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The JOURNAL OF RADIOLOGY
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The Roentgenologic Aspects of Osteitis Deformans Pagets Disease, with Reports of 15 Cases*

R. D. CARMAN, M. D.,
Head of Section of Roentgenology, Mayo Clinic.
W. M. CARRICK, M. D.,
Fellow of Roentgenology, The Mayo Foundation.
Rochester, Minn.

Case 1 (106274)

MR. O. O. P., aged 55, came to the Clinic May 19, 1914, complaining of weakness and numbness of the extremities.

Twenty-five years before the patient had measured six feet in height. For the past 10 or 15 years he had gradually decreased in stature. About five years before he noticed a slight pain in hands and feet, not constant, but associated with weakness and a general tired feeling. He continued to do his work until five months before when he was obliged to use crutches and then a wheel chair. He had been poisoned by wall paper, the arsenic causing swelling of the face and "weeping" from the legs and body. This lasted one summer. He had been a general house painter but stated that he had never had lead poisoning. His appetite had been good. He had been a heavy user of tobacco.

Clinical Findings.

The patient appeared poorly nourished, was four feet, five and three-quarters inches tall, with a marked kyphosis of the upper dorsal spine. A "cracking" sound was heard on movement of the spine; the neck and lumbar region were stiff; the chest had a marked barrel shape. There was a heart dullness of four and one-half inches with forcible diffuse impulse; rough systolic murmur was heard over the precordium with a maximum intensity at the aortic area. The patient's legs were slightly edematous; he had a large hydrocele on the left side. The lungs were negative. The systolic blood pressure was 165, the diastolic 105; the blood showed a secondary anemia, the hemoglobin being 60 per cent. The urine was normal and the Wassermann test was negative. No history could be obtained of enlargement of the cranium. The legs were bowed

anteriorly, the deformity being more marked on the left side.

Roentgenologic Findings.

Osteitis deformans of the left tibia and spine. (Fig. 1).

Fig. I.—Case 106274—Tibia, showing irregular bone absorption, thickening, and trabeculation. Note bowing of the tibia and arteriosclerosis.

Case 2 (178377)

Mr. W. J. A., aged 51, came to the Clinic November 21, 1916, complaining of bladder trouble. Fourteen years before the right testicle had been removed on account of tuberculosis. The patient went home and returned to the Clinic April 26, 1917, when the right kidney was removed. Paget's disease was not diagnosed.

The patient again came to the Clinic April 3, 1919, complaining of pain in the right hip, down the back to the thigh and right leg. He had had these pains for four or five years and thought they had become worse since the nephrectomy in 1917. He had similar pain in the left hip although not so severe as in the right. He also complained of a feeling of weakness in the lower spine.

Roentgenologic Findings.

Osteitis deformans of the pelvis and the right tibia (Fig. 2).

Fig. II.—Case 178377—Roentgen findings similar to those in Figure I.

Case 3 (178770)

Mr. T. M. W., aged 62, came to the Clinic November 24, 1916, complaining of "tumor of the right thigh, old fracture of the upper part of the right femur and loss of motion of the right leg."

Twenty-five years before he had begun to have weakness and lameness in the right hip, which gradually became worse. The leg shortened and he wore an extra heel for correction. The right tibia had been growing thicker during

the last 15 years. January 23, 1916 he made a mis-step and fell to the floor fracturing the right femur. He said he did not think the fall was enough to have broken a "sound leg". He was put to bed and his doctor told him he could do nothing for him. Eight months after this accident he noticed an increasing swelling of the right thigh.

Clinical Findings.

The patient was five feet, eight inches tall and weighed 150 pounds. He had a moderately firm tumor of the upper third of the right femur and thigh, the circumference of the leg was about three times normal; it was kept in a position of abduction and external rotation. There was loss of active motion; passive motion was slight and painful in any direction. The right tibia was twice the normal size. The Wassermann reaction was negative.

Roentgenologic Findings.

Osteitis deformans of the right tibia and lower part of the right femur. Mixed-cell sarcoma in the upper half of the femur with pathologic fracture (Fig. 3).

This patient died at his home six weeks after leaving the Clinic. Necropsy was not obtained.

Case 4 (212968)

Mrs. H. J. L., aged 44, came to the Clinic first November 5, 1917, complaining of pains in the elbows, hips, and fingers. For two years her left hip, knees, and ankles had been stiff. She gave a history of a genital sore, but the

Fig. III.—Case 178770—Irregular rarefaction; thickening and trabeculation of the femur. This is especially marked along the convex surface of the bone.

Wassermann reaction proved to be negative. The general physical examination revealed nothing of importance. The roentgenologic findings were "marked increased density of the bone of the pelvis and upper part of left femur, with widening of the shaft; probably metastasis." The patient was sent home by the consultant after having been given a negative diagnosis.

January 22, 1919, the patient returned to the Clinic complaining that the left hip and knee had become stiffer and the fingers more painful. A roentgen diagnosis of probable metastasis was again made. The orthopedist considered the condition chronic osteitis, suggestive of an oncoming Paget's

anteriorly, the deformity being more marked on the left side.

Roentgenologic Findings.

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Roentgenologic Findings.

Osteitis deformans of the right tibia and lower part of the right femur. Mixed-cell sarcoma in the upper half of the femur with pathologic fracture (Fig. 3).

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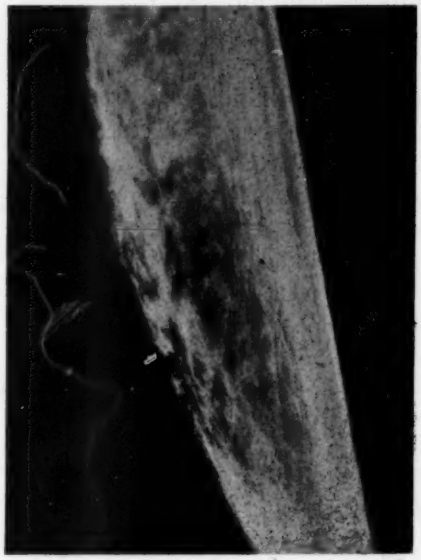

Fig. III.—Case 178770—Irregular rarefaction; thickening and trabeculation of the femur. This is especially marked along the convex surface of the bone.

Wassermann reaction proved to be negative. The general physical examination revealed nothing of importance. The roentgenologic findings were "marked increased density of the bone of the pelvis and upper part of left femur, with widening of the shaft; probably metastasis." The patient was sent home by the consultant after having been given a negative diagnosis.

January 22, 1919, the patient returned to the Clinic complaining that the left hip and knee had become stiffer and the fingers more painful. A roentgen diagnosis of probable metastasis was again made. The orthopedist considered the condition chronic osteitis, suggestive of an oncoming Paget's

disease and advised re-examination in one year.

April 5, 1920, the patient again came to the Clinic with the same complaint. She was called home before her examination was completed, but the roentgenograms show the typical changes of osteitis deformans throughout the left femur and hip and involving the pelvis. No plates of the skull were made (Fig. 4).

Fig. IV.—Case 212968—Left hip. Ivory-like appearance, due to increased density and thickening.

Case 5 (213032)

Mrs. M. H. S., aged 45, came to the Clinic November 7, 1917, complaining of dizziness, pain in the head, and failing sight and hearing, first noticed about 1916. She began to suffer from headaches in the occipital and frontal regions and noticed that her head was enlarging. She had spells of dizziness and falling to the right side, which lasted about one minute; she was always sleepy and fell asleep in her chair while talking.

Clinical Findings.

The patient was five feet, one inch in height, and weighed 130 pounds. Her head was large and square looking and the temporal vessels were large and tortuous. The roentgenographic examination of the skull showed the skull bones increased in thickness and a rarefying process in the bony structure of the vault. There was a systolic murmur at the apex, not transmitted. Vision and pupils were normal, light reflexes were sluggish, the outline of the right disc was rather hazy, and the nerve head somewhat filled in. She had medium sized tonsils and an atrophic rhinitis. The ear membranes were thickened and retracted. The blood and spinal fluid were negative to the Wassermann test. There was a moderate jaw jerk. Arm, knee, and Achilles reflexes were slightly increased. Plantar reflexes and sensation were normal. The coordination of the left hand was somewhat poorer than that of the right. Pronation and supination tests were somewhat disturbed in the left hand; the gait was uncertain.

The Barany tests showed lack of reaction of the semicircular canals on both sides when stimulated by cold douching; a slight rotary nystagmus on the left side was manifest and there was tinnitus and vertigo on both sides, possibly associated with the bony changes in the skull.

Roentgenologic Findings.

Paget's disease of the skull.

Case 6 (237362)

Mrs. E. P., aged 60, came to the Clinic July 11, 1918 complaining of tumor of the left breast and pain in the right leg. The patient's left nipple had been burned with an electric needle 18 months before on account of "a pimple" that ulcerated and would not stay healed after being scabbed over.

About two months before the patient had noticed a lump in the breast. It had given no real pain but had enlarged. Pain in the right leg was first felt eight or ten years before. It was worse at night and interfered with sleep. Afterward it pained only when the patient first began to walk and when the full weight was put on the leg. She had noticed some discomfort in the left leg also.

Clinical Findings.

The patient appeared healthy and younger than her age. She weighed 124 pounds and was four feet, eleven inches in height. A tumor mass was noted in the upper half of the left breast. The right knee joint was enlarged and a little stiffened; the right tibia was enlarged, bowed forward and outward. The tonsils were moderately enlarged and exuding pus. The systolic blood pressure was 130, the diastolic 80. Examination of the heart, lungs, urine and other systems proved negative.

A radical amputation of the left breast was performed. Operative and pathologic reports showed diffuse carcinoma in the upper and inner quadrant of the left breast, probably secondary to Paget's disease of the left nipple, and fairly extensive glandular involvement.

Roentgenologic Findings.

Osteitis deformans of the right tibia.

Case 7 (238596)

Miss L. T., aged 37, was admitted to the Clinic July 18, 1918 complaining of aching in the legs with occasional sharp pains and paralysis of the left side of the face which had begun four years before with quivering of the facial muscles and pain behind the left ear.

The patient stated that she had had the pains and aching in the legs since childhood and that it was always much worse at night. Her general strength had decreased and she was unable to walk far. She had no earache or headache, but became dull of hearing in the left ear.

Clinical Findings.

The long bones were found roughened and enlarged and the skull was enlarged. The left seventh cranial nerve was paralyzed. Marked pyorrhea and enlarged tonsils with occasional plugs were found. The eyes were normal; the urine showed a small amount of albumin; the blood showed slight anemia. The systolic blood pressure was 116, the diastolic 76. The Wassermann and spinal fluid

reactions were negative. The basal metabolic rate was -1.

Roentgenologic Findings.

Osteitis deformans of head, left tibia and fibula, right femur, both radii and ulnæ, several metacarpals, and lower jaw (Figs. 5 & 6).

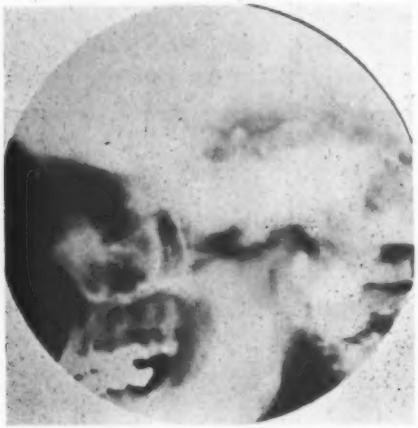

Fig. V.—Case 238596—Increased thickening and density at the base of the skull and lower jaw.

Fig. VI. — Case 238596 — Marked thickening and density of the radius, ulna, and metacarpal bones. Note the areas of rarefaction, irregularity of outline, and absence of joint involvement.

Case 8 (252310)

Mrs. A. B., aged 66, came to Clinic December 2, 1918 complaining of pain and stiffness in the left hip with shortening of the left leg.

Thirteen years before the patient began having pain in the left hip causing a slight limp. The pain continued, never very sharp but constant and becoming worse after exercise. The stiffness in the hip, shortening of the leg and the limping had grown gradually more marked in the last five years and she had not been able to walk without crutches. The right knee joint had been slightly stiff from acute arthritis 29 years before.

Clinical Findings.

The patient was unable to walk without two crutches; her color was good and she appeared well nourished and well-developed. Her upper teeth were artificial; in the lower teeth pyorrhea was fairly marked; the tonsils were enlarged, with plugs. The systolic blood pressure was 140, the diastolic 50. Urinalysis showed a moderate amount of albumin and some pus cells; the blood count was normal and the Wassermann test was negative. The left hip could not be rotated or abducted, but there was good flexion and extension. The thigh was curved outward and the left leg greatly shortened. An intra-uterine fibroid was causing metrorrhagia for which radium was advised. The examinations of the heart, lungs, abdomen, and other systems were negative.

Roentgenologic Findings.

Osteitis deformans of the left hip and thigh; the right ilium and femur showed marked bone changes. There was general calcareous arteritis (Fig. 7).

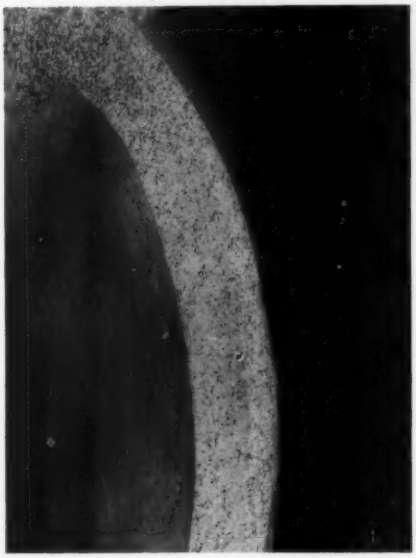

Fig. VII. — Case 252310 — Femur thickened and bowed.

Case 9 (302252)

Mr. F. C. P., aged 45, came to the Clinic January 10, 1920, complaining of dull aching pain in the abdomen, and a backache, of about four years' duration. Jarring of the spine caused pain in the back. He had occasional dull headache. Three years before he had been told he had tuberculosis of the intestines and for 18 months was given a tuberculin injection every six days.

Since the first year the pain had been limited to the lower abdomen and was practically constant. The patient became tired easily and when tired his legs ached and the muscles trembled. His appetite was fair, his bowels regular; there were no urinary symptoms.

Clinical Findings.

The patient was anemic and sick-looking and carried himself in a slightly stooping attitude. The heart and lungs were normal, pyorrhea was marked; the abdomen was slightly distended but no mass could be felt. The last ribs practically touched the iliac crests.

Examination of the eyes, ears, and throat showed nothing of importance. Urinalysis showed a small amount of albumin and the combined phenolsulphonephthalein test was normal. The examination of the blood was negative and the Wassermann test was negative.

Roentgenologic Findings.

The roentgenologic examination showed irregular absorption of

Fig. VIII. — Case 302252 — Head, showing thickening of the skull and irregular nodular deposits of bone.

the vertebræ and thickening in the pelvic bones, thought to be metas-

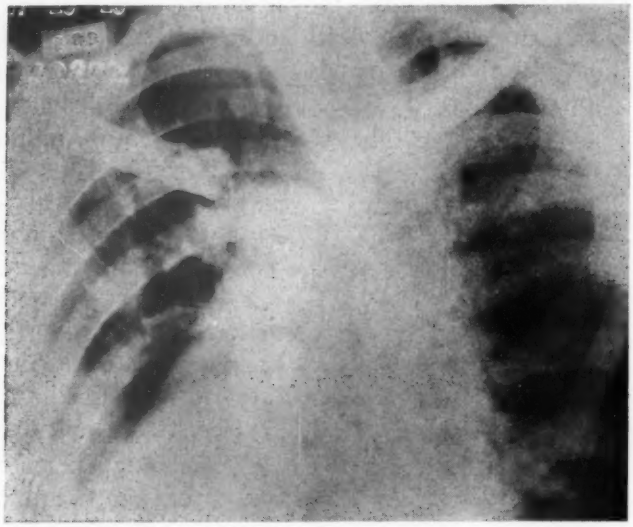

Fig X.—Case 302252—Involvement of the sternum.

tasis. No primary malignant lesion could be found.

The patient was fitted with a back brace which gave relief from the pains. He returned to the Clinic November 26, 1920 for re-examination. He was slightly stooped over and both legs were bowed forward and outward. He said that his head is enlarging and that he is about three inches shorter than he used to be. When

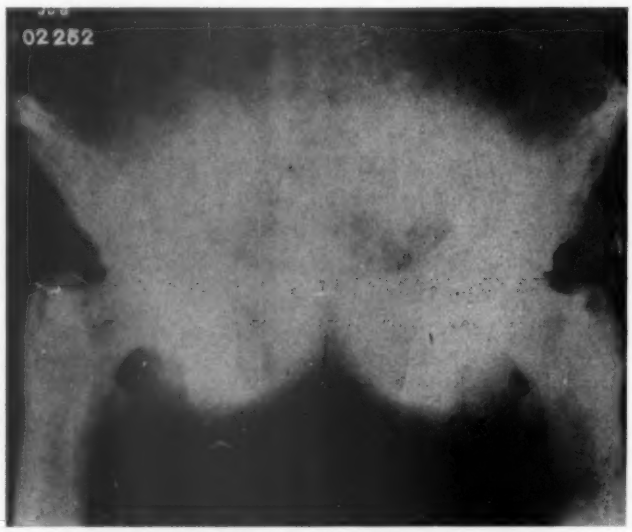

Fig. IX.—Case 302252—Marked thickening of the pelvis and hips and rarefaction of the alae illi.

his spine was rayed the plates showed marked thickening and eburnation of the spine and pelvis. Plates were then made of the skull and other structures and the characteristic bony changes of osteitis deformans were found in the skull, right clavicle, sternum, and tibiæ (Figs. 8, 9, and 10).

Case 10 (309410)

Mr. R. C. K., aged 60, was admitted to the Mayo Clinic March 18, 1920, complaining of disturbance of hearing and right sided facial spasm.

The present trouble had begun seven or eight years before with hammering in the right ear described by the patient as being "like the whistle in a peanut roaster", and loss of hearing in that ear. The ear had not ached or discharged. The hammering had been constant although not rhythmic with the pulse, but a rhythmic noise accompanied it like a muffled drum beat. These noises did not increase in intensity, but other symptoms developed in order of sequence as follows:

1. Twitching of the muscles of the right eye beginning at the outer corner gradually extended to involve the muscles of the whole right side of the face. Occasionally an involuntary spasm of the right facial muscles closed the right eye. A slight fullness of the left cheek was first noticed about six months before. The patient was unable to whistle well because of spasm of the facial muscles. He had never had double vision.

2. Symptoms of incoordination were noted. The patient could think well, but found difficulty at times in expressing himself. He had had no difficulty in writing, other than slowness and some unsteadiness of movements. His memory had been excellent for all events, recent and remote. During the past six months he had noticed difficulty in walking, was ataxic and uncertain of movements, without muscular weakness.

3. The patient had severe headaches at the base of the skull on coughing, associated with transitory blindness.

4. During the past five years the patient had decreased about three inches in stature, and his head had enlarged, necessitating a change in the size of his hat from 7 to 7⅝, which is now too small.

Clinical Findings.

The patient was five feet, four inches in height and weighed 135 pounds. His attitude was slightly stooping, his legs somewhat bowed, his head large and pyramidal in shape with the apex downward. The vessels of the scalp were tortuous and sclerotic. The examination of eyes and ears was negative. The urinalysis showed a small amount of albumin. The Wassermann and spinal fluid reactions were negative. The blood count showed no abnormality and the basal metabolic

rate was +14. The neurologic examination showed nothing of importance, the summary being: ptosis of the right eyelid, continual twitching from platysma to right orbicularis oculi, taste defective, salt and sour being —3 on both right and left sides, Rombergism, and sensory aphasia to slight degree. Mental and motor apraxia +1, +2, (gradations on a scale of 1 to 4). A tentative diagnosis of cortical lesion due to bony changes was made by the neurologists. The systolic blood pressure was 120,, the diastolic 60.

Roentgenologic Findings.

Paget's disease of the head and the left tibia (Fig. 11).

Fig. XI.—Case 309410—Skull enlarged, inner table increased in thickness and density, outer table increased in thickness, irregularity and finely porous. Nodular areas of bone scattered over the vertex.

Case 11 (318460)

Mr. G. H. P., aged 56, was admitted to the Clinic June 24, 1920, complaining of pains in the legs. The patient had had rheumatic fever 20 years before and again in five years. When he was 26 he had renal colic and passed a stone. He had had a fracture of the left elbow ten years before and both scapulæ were fractured five years later. He had had a chancroid at the age of 55.

The patient first noticed a dull painful aching in the right tibia at night about three years before; it was relieved by rubbing. Eight weeks before examination he began to have steady pain along both tibiæ accompanied by swelling at the lower third of both legs. Bowing of the legs had been noticed in the last three to four years and gradual enlargement of the head during the last five years.

Clinical Findings.

The patient was 5 ft., 6 ins. in height and weighed 133 pounds. The skull was enlarged, triangular shaped with its base above and frontal bones quite prominent; the clavicles were thickened and excessively curved; the iliac crests were thickened and the pelvis; widened, giving it an increased intercristal diameter; and the lower extremities were bowed outward and forward. The femora and tibiæ were thickened, more particularly the right tibia at its lower end. The arms appeared relatively too long. The palpable arteries were tortuous and sclerotic. There was a large sized inguinal hernia on the right side. The systolic blood pressure was 142; the diastolic 86. The eye examination was negative except for a very slight evidence of retinal vascular sclerosis. Repeated urinalysis showed a relatively low

specific gravity 1013 and 1017, and a moderate amount of albumin and occasional red and white blood cells. The combined phenolsulphonephthalein test showed 30 per cent excreted in two hours and fifteen minutes. The hemglobin was 70 per cent; the erythrocytes 4,600,000, the leukocytes varied from 9,000 to 16,800, and 55 per cent of 200 cells were polymorphonuclear neuthrophils; 36 per cent were small lymphocytes; 8 per cent were large lymphocytes, and 1 per cent were eosinophils. The Wassermann test and the neurologic examination were negative; the basal metabolic rate was +24.

Roentgenologic Findings.

Paget's disease of the head, spine, pelvis, right and left femur and left tibia. On the roentgenograms of the kidneys, ureters and bladder a diagnosis of metastasis in the spine and pelvis was made.

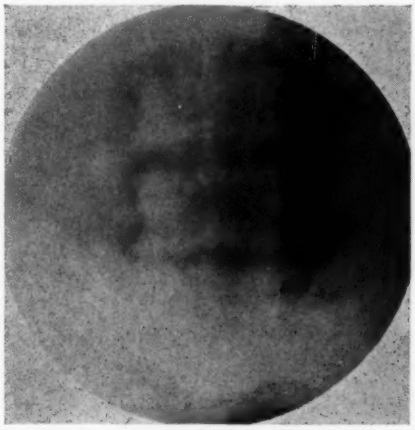

Fig. XII.—Case 318460—Involvement of the lumbar spine and sacroiliac region. The density of bone similates bone metastasis.

Roentgenograms of the head disclosed the correct diagnosis of Paget's disease (Fig. 12).

Case 12 (327522)

Mrs. C. W. F., aged 49, was admitted to the Clinic August 3, 1920, complaining of general rheumatic pains and bow legs.

About six years before the patient began to have a general heavy sluggish feeling, especially when lying down. She consulted a physician who said the condition was due to lack of thyroid secretion and put her on thyroid extract which she says caused marked improvement in her health within one month. The treatment was discontinued for three months and the symptoms returned. She was again put on thyroid extract, one or two tablets a week, with improvement, which medication has been kept up for the last five years. Four years before the patient had had an acute attack of general neuritis, the pains being most marked in the left shoulder, and was confined to bed for three days. Since then she had had frequent pains over all the body, aggravated during cold weather. Two years before she sustained a slight injury to the right knee. Her physician drew attention to the fact that the bones of the legs were bowed outward. The injury to the knee was apparently trivial and the patient was up and walking in a few days. Subsequently, she had one or two slight injuries to the same knee, not accompanied by locking of the joint or swelling.

She thinks that during the last three years there has been a marked increase in the bowing of the legs.

Clinical Findings.

The patient was found to be well nourished, she weighed 115 pounds and was five feet, one and one-half inches tall. A systolic murmur at the apex of the heart transmitted to the axilla was noted. The abdomen and pelvis were negative; there was no evidence of thyroid disturbance. The systolic blood pressure was 150, the diastolic varied from 60 to 80. The eyes, ears, nose, and throat were normal. The urine and blood examinations and Wassermann reaction were negative. The basal metabolic rate was —5.

Roentgenologic Findings.

Paget's disease of both tibiæ.

Case 13 (328746)

Mr. L. E. S., aged 70, came to the Clinic August 12, 1920, complaining of pain and bowing of the left leg.

About seven years before he had noticed that his left leg was crooked and that it pained occasionally, becoming worse in the last two years and finally severe enough to interfere with sleep.

Clinical Findings.

The patient weighed 172 pounds. The left tibia was bowed forward and outward, was tender to the touch, and appeared thickened. The movement of the spine appeared slightly limited. The prostate was slightly enlarged. The teeth showed some pyorrhea. The heart, lungs, and other organs were negative. The urine contained a small amount of albumin with some hyaline casts. The Wassermann reaction was negative.

Roentgenologic Findings.

Paget's disease of the left tibia.

Case 14 (337496)

Mr. G. W. G., aged 50, came to the Clinic October 13, 1920, complaining of pain in the head and difficulty in walking.

Several years before the patient had been subject to severe headaches occurring two or three times a week. The headaches came on suddenly, lasted all day, and were severe enough to prevent him from working. The headaches had not been so frequent or severe during the last year. About two years before he had a fall on the street and was laid up for two days. Two weeks later he had an

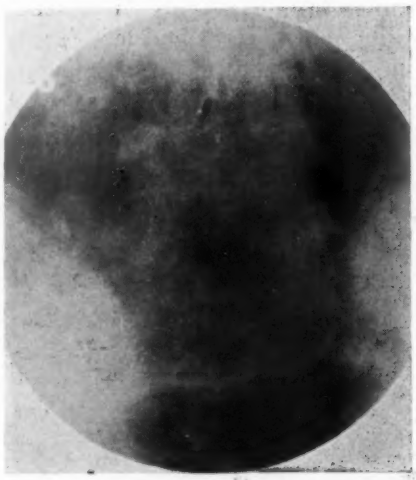

Fig. XIII.—Case 337496—Rarefaction and trabeculation of the lumbar spine and sacro-iliac region.

attack of some kind and was unconscious. He was kept in bed for three months and during this time had a dull continuous pain in the lumbar region. He walked about with a cane, in a stooped position, and complained of pain and stiffness in the back. He had had to urinate four or five times during the night and three or four times during the day.

Clinical Findings.

The patient apparently had not decreased in stature and had no deformity of the extremities. His head was enlarged and pyramidal shaped. He had mature right and left senile cataracts. The systolic blood pressure was 125, the diastolic 70. The blood count was normal. The urine contained a slight amount of albumin and a few pus cells. The combined phenolsulphonephthalein test was normal. The Wassermann test was negative.

Roentgenologic Findings.

In the general examination of the patient plates were made of the kidneys, ureters and bladder. On the appearance of the spine and sacro iliac region a diagnosis of metastasis was made. The patient was returned to the roentgen laboratory for re-examination and attention was drawn to the size and shape of the head. Plates of the head were made and showed defin-

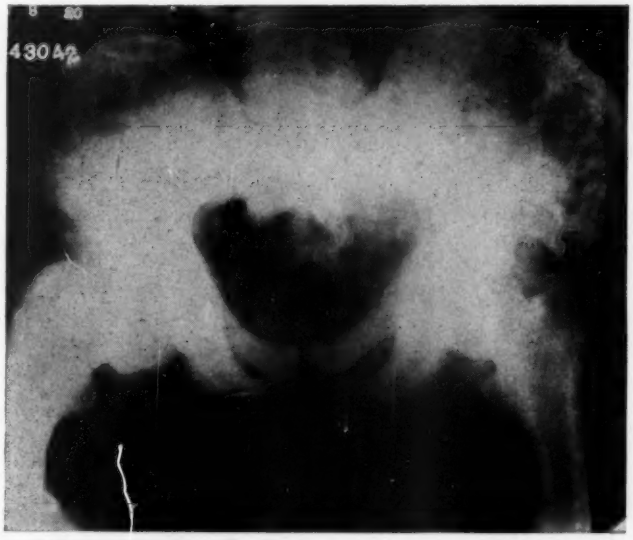

Fig. XIV.—Case 343042—Marked involvement of the pelvis, right hip, and femur, with early involvement of the left hip.

ite osteitis deformans (Fig. 13).

Case 15 (343042)

Mr. D. B., aged 46, came to the Clinic December 7, 1920 complaining of a tumor in the region of the left hip.

About 14 years before the patient began to notice that his right

thigh was becoming bowed and his leg getting shorter. This progressed for three years, unaccompanied by pain or other symptoms. Six and one-half years before, while playing tennis, he had had a sudden attack of severe pain in the sacral region, not sufficient, however, to confine him to bed. Six months later when running to catch a boat, he fell and injured his left hip. He was in bed ten days, used crutches for three months and a cane for one year. His physician said he had torn some ligaments. One year later, five years before examination, he noticed a rapidly growing tumor above the left hip; this did not cause pain.

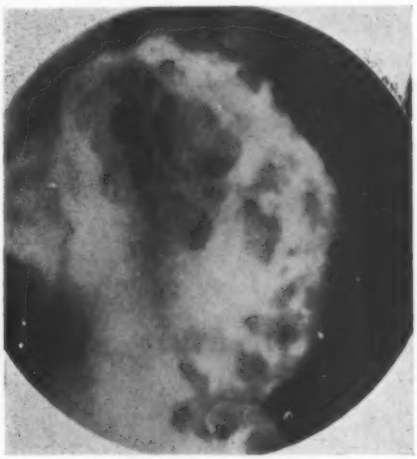

Fig. XV.—Case 343042—Close-up view of the left ilium, showing enlargement, areas of absorption varying in size, and coarse trabeculation somewhat resembling giant-cell tumor. Absorption to this extent is an unusual finding in Paget's disease

Clinical Findings.

The patient appeared well nourished. His head was not enlarged; the spine was not deformed. The right femur was very markedly bowed forward and outward, and there was a large hard mass in connection with the left ilium. The skin over the mass was covered with distended veins.

The urinalysis showed a large amount of albumin and a moderate amount of pus cells; the blood count was normal and the Wassermann reaction negative. The systolic blood pressure was 132 and the diastolic 84.

Roentgenologic Findings.

The examination of the left ilium and hip showed osteitis deformans of the femur. The ilium was enlarged in all directions, and showed large irregular areas of bone absorption with coarse trabeculation between these areas. Further plates showed the disease in a very early stage in the skull and left femur, and to a marked degree in the spine, pelvis, and right femur (Figs. 14, 15 and 16).

Before entering on a discussion of the subject of this disease it may be of interest to call attention briefly to the eminent surgeon who first described it and whose name is associated with it. The original article is a masterpiece and the fact that none of the many subsequent writers has added anything to our knowledge of the disease is a great tribute to the accuracy of observation and the completeness and lucidity of the description.

Discussion

The British Encyclopedia gives the following account of Sir

James Paget. He was born in 1814 at Yarmouth, apprenticed to a general practitioner from 1830 to 1834, entered St. Bartholomew Hospital as a student in 1834, where he discovered the *Trichina spiralis* in the muscles

Fig. XVI.—Case 343042—Lumbar spine and sacro-iliac region. Note the chalk-like appearance of the bone, flattening and widening of the bodies of the vertebrae.

of the specimen he was dissecting as a first year student. From 1836 to 1843 Paget practiced general medicine, but found it necessary to prepare catalogs for the pathologic museum of the Royal College of Surgeons in order to make a living. He was curator of this museum from 1836 to 1838, after which he was demonstrator of morbid anatomy in the same institution. In 1841 he became surgeon to the Farisbury dispensary and in 1843 was appointed lecturer on microscopic anatomy. In 1847 he was made assistant surgeon and professor of surgical pathology, and through his lectures restored the Royal College to its former leading position. In 1851 he was elected fellow of the Royal Society and became eminent as a pathologist and physiologist. His best original work was a description of eczema of the nipple with subsequent mammary cancer, and the bone disorder, osteitis deformans, both of which are named after him. Later in life he became Surgeon Extraordinary to Queen Victoria, President of the Royal College of Surgeons, and Vice Chancellor of the University of London.

The preparation of this paper was stimulated by the fact that four cases of osteitis deformans were diagnosed by means of the x-ray as metastasis in bone. After further study and re-examination of other bones, more especially those of the head, a correct diagnosis was made. While no new facts or theories are brought out in this report, the disease is so rarely seen and so often unrec-

ognized that we felt the subject would be of interest to clinicians and roentgenologists alike.

Sir James Paget, in 1876, reported five cases and in 1882 seven additional cases of an unusual bone condition which he termed osteitis deformans. In 1890, 14 years later, he had seen altogether 23 cases of the disease. From that time until the present approximately 250 cases have been reported in the literature. How infrequently the disease is seen may be estimated from the fact that three cases were observed in 38,000 admissions to the New Jefferson Hospital, Philadelphia, during seven years; three cases in 30,000 admissions to Johns Hopkins Hospital, and the foregoing series of 15 cases in 237,000 admissions to the Mayo Clinic in six years.

Etiology.

The cause of the disease is unknown. Arteriosclerosis, heredity, syphilis, trophic disturbances, and faulty metabolism have been mentioned by different writers as possible causes, but a study of the literature and of our cases does not substantiate any of these as etiologic factors.

Pathology.

The disease affects most frequently the long bones of the lower extremities and the bones of the skull. The bones become thickened and softened and those bearing weight become bowed. These changes are followed by the production of poorly calcified bone which after a period of years takes on an ivory-like hardness.

The bones of the skull show marked thickening, in some cases to four times the normal; the inner table is dense and the outer table finely porous, producing in the roentgenogram a fuzzy appearance of the calvarium. Nodular deposits of bone are irregularly distributed over the vertex. The marrow cavity is sometimes obliterated by the formation of fibrous soft-bone tissue which usually becomes trabeculated. There may be great rarefaction of bone in one extremity with increased density of bone in other extremities in the same patient. Writers are at variance regarding the beginning of the disease process, but all who have studied the pathology of the bone changes describe similar microscopic pictures. Packard, Steele and Kirkbride describe the process as follows:

"1. Absorption of the compact substance, causing enlargement and confluence of the Haversian canals.

"2. Formation of new bone which runs diffusely through the affected and adjacent healthy portions. This new bone remains uncalcified and is in turn reabsorbed.

"3. The conversion of the medullary substance into a vascular connective tissue containing fat cells, giant cells, and leukocytes. In a small proportion of cases cysts filled with gelatinous

material and giant-celled sarcomas occur in the medulla.

"4. As a consequence of these three processes the ordinary relations of the compact substance and medulla are destroyed. The bones become greatly thickened and asymmetrical, but since the new bone tissue remains uncalcified, the elasticity permits of great deformity of the long bones from weight of the body, and fractures do not occur."

Morton Prince speaks of the pathology of the disease under three separate divisions, namely, (a) absorption of bone; (b) new formation of bone without calcification; and (c) new formation of bone with calcification. Any one process may predominate.

Clinical History and Physical Findings.

Osteitis deformans is a disease affecting the middle aged and the elderly, practically all the cases occurring in persons over 40. In Case 7 (238596) of our series the patient was 37 when the condition was diagnosed; the other 14 patients of the series vary in age from 40 to 70. Males are said to be affected more frequently than females. In this series there were nine males and six females.

The onset is insidious and the course of the disease slowly progressive. One of the first symptoms complained of by many patients is pain and aching in the legs. The pain is neuralgic or rheumatic in character and frequently complaint is made of a burning feeling over the tibiæ, accompanied by increased heat to the touch over the same areas. A number of cases have been reported in which there was no pain throughout the course of the disease. Twelve patients of our series had pain in the extremities, two complained of pain in the head, and one had no pain. Bowing of the legs is an early finding in cases in which the lower extremities are affected.

The general appearance and posture of the patient is quite characteristic. The head, which is increased in size, is carried forward and shaped like an inverted triangle. The increase may have been noticed by the patient himself, who finds that he requires a larger hat from time to time. The superficial vessels of the scalp are often prominent, tortuous, and sclerosed. There is loss of height, the shoulders are rounded, and the spine is curved forward, tending to bring the costal margin almost in contact with the iliac crests. The chest appears sunken and the abdomen pendulous; the pelvis is widened and seems disproportionate to the rest of the body. The legs are bowed forward and outward and they are everted when the patient is standing. The patient has a slow awkward gait.

Arteriosclerosis occurs frequently in case of osteitis deformans, and in the late stages of the disease myocardial changes are common. Paget emphasized the frequency with which malig-

nancy, either of bone or other tissue, complicates the disease. Five of his eight patients who were traced to death, died of malignant disease. Since his observations several writers have drawn attention to this fact. Two patients in our series developed malignant disease, one carcinoma of the breast, and the other sarcoma of the femur, which bone was also affected with osteitis deformans. In four cases the basal metabolic rate was studied, but no conclusions could be made from the varying rates, +14, +24, —5, and —1. The accessory sinuses of the nose and the pituitary fossa revealed no abnormalities.

Spontaneous fracture in Paget's disease is considered rare by most observers. LeWald in a study of 14 cases encountered four in which spontaneous fracture had occurred. In one of our cases a pathologic fracture occurred through a sarcomatous tumor in the upper third of the femur.

In regard to the prognosis of the disease: The course is protracted and death occurs from some intercurrent disease.

Roentgenologic Findings.

Roentgenography has demonstrated that many bones are affected in osteitis deformans, the order of frequency being as follows: Tibia, femur, skull, pelvis, spine, clavicle, ribs, radius and ulna. It is rarely seen in the hands, feet, or bones of the face.

The whole architecture of the bone is altered, the essential features being porosis and the formation of new bone with hyperostoses, one or the other process predominating in different parts. In later stages the new bone tends to become sclerosed and takes on a dense white appearance, with a much decreased permeability to the x-rays. The structure of the bone appears to be almost entirely removed and laid down afresh on a different plan and in a larger mould.

According to the literature, the consensus of opinion seems to be that the bones of the face remain unaffected. In Case 7 (238596) the lower jaw showed the marked thickening and density of Paget's disease.

The long bones lose their clear cut outline; they become curved, and the thickening appears to be greatest on the convex surfaces. In some places subperiosteal thickening is seen, while in others decalcification beneath the periosteum has progressed irregularly. The small cysts frequently mentioned in the literature were observed but once in our cases.

The spine and pelvis, when affected, take on a dense white appearance, or the picture may be that of porosity with fine and coarse trabeculation, or there may be a combination of the two. The bodies of the lumbar vertebræ are flattened and widened compared with the normal. The joints are not involved; the process extends throughout the epiphyses, but there is no noticeable irregularity

of the joint surfaces. There is no approximation of the articular surfaces that is suggestive of atrophy of the cartilages.

It has been said by some authors that the long bones of the lower extremities and the bones of the skull are most frequently affected, but it is probable that other bones would be found to be as frequently involved, except in the very early stages of the disease, if the patients were systematically examined with the x-rays. The multiplicity of bones that may be involved in one patient is shown in Case 7 (238596) in which the head, left tibia, left fibula, right femur, both radii and ulnæ, lower jaw, and several metacarpals were affected; and in Case 9 (302252) in which the skull, spine, pelvis, right clavicle, sternum, and tibiæ were involved.

Cases have been reported of single bone involvement under the name "mono-osteitic type." The question arises whether the x-ray might not have revealed the lesion in other bones as well. Beclere reports one case in which metacarpals and phalanges were involved. Goldthwait, Painter and Osgood describe a similar case. Case 7 (238596) shows involvement of the metacarpal bone of the index finger of the left hand and of the metacarpals of the index and middle fingers of the right hand.

Differential Diagnosis.

Osteomalacia.

The differential diagnosis of this disease and osteitis deformans should present little difficulty either from the roentgenologic or clinical standpoint. The bone change in osteomalacia is that of decalcification and when deformity occurs it is angular. The cortex of the bone becomes very much thinned and spontaneous fractures are common.

Syphilis.

In this disease there is marked periosteal overgrowth and increased thickening of the cortex at the expense of the medullary cavity. Codman has applied the name "bone-blister" to the localized periosteal elevations. The thickening of the cortex is most common along the convex side of the affected bone, producing the appearance of bowing as seen in the so-called "sabre-tibia."

The x-ray picture of the disease in the spine and in the skull is so different from that of osteitis deformans as to require no differentiation.

For additional proof we must rely on the history, the Wassermann reaction, and the examination of the spinal fluid.

Osteomyelitis.

In this disease there is tendency to formation of bone abscess in the early stages, and thickening and sclerosis with the formation of sequestra in the later stages. Porosity may be present, although not a characteristic of the disease, and results from non-use. The disease is usually confined to one bone and the history of the case

is entirely different from that of Paget's disease.

Secondary Malignancy in Bone.

The osteoplastic type of metastasis is the one condition that may easily be mistaken from the x-ray standpoint for osteitis deformans, especially when the latter disease occurs in the lumbar spine and sacro-iliac region.

LeWald appears to be the only writer to mention the possibility of mistaking Paget's disease for bone metastasis, and he considers that possibility only when the Paget's disease is confined to one bone.

The bone lesion in four of our cases was mistaken for metastasis because of the dense white chalky appearance of the lumbar spine and sacro-iliac region. In Case 4 (212968) the x-ray appearance of the femur led to a diagnosis of metastasis in 1917. Fourteen months later the same diagnosis was made. However, in spite of this roentgen diagnosis the surgeon suggested the possibility of oncoming Paget's disease. In April, 1920, on re-examination of the patient, the same roentgen diagnosis was made. The patient was called home before her general examination was completed. During the review of this series of cases the plates of this patient were studied and the bone changes were found to be unquestionably those of osteitis deformans.

In Case 9 (302252) the roentgen diagnosis made January, 1920 was metastasis of the lumbar spine and pelvic bones. No primary malignancy could be found and the patient was fitted with a back brace which relieved the pain. This patient returned to the Clinic November, 1920. The spine was re-examined and revealed the dense, white appearance which we had learned to associate with Paget's disease. The patient was sent for and plates made of the skull and other bones, which showed the characteristic bone changes of osteitis deformans in the skull, right clavicle, sternum, and tibiæ. During this examination it was noticed that the man had many of the clinical appearances of the disease.

In Case 11 (318460), the clinician was investigating some urinary condition and requested an x-ray examination of the kidney, ureter and bladder areas. The appearance of the lumbar spine and sacro-iliac region in these plates led to a diagnosis of bone metastasis. For some reason a roentgenogram of the skull had been asked for also, and the bone changes that were revealed corrected the diagnosis.

In Case 14 (337496) during the general clinical examination roentgenograms of the kidney, ureter and bladder regions were asked for. The white, dense lumbar spine and sacrum again caused an incorrect diagnosis of metastasis. The clinician could find no primary lesion and asked for a re-ray. When the patient presented himself for examination attention

was drawn to the size and shape of his head. Roentgenograms of the skull showed definite osteitis deformans and the correct diagnosis was made.

Because of the close similarity between osteoplastic metastasis and osteitis deformans when they occur in the spine and pelvis, a very careful search should be made for primary malignancy, and other bones, more especially those of the skull and the extremities, should be roentgenographed for evidences of osteitis deformans. If these bones show absorption and production of new bone, the lesion unquestionably is Paget's disease. As mentioned before, the bodies of the lumbar vertebræ are flattened and widened in osteitis deformans, whereas in malignancy there is little if any change in the shape of the vertebræ. If the skull shows the pathognomonic changes of osteitis deformans, that is, thickening and density of the inner table, thickening and the finely porous appearance of the outer table, with scattered nodules of bone over the vault, the diagnosis is certain.

In the osteoclastic and mixed osteoplastic and osteoclastic types of metastasis the differentiation should not be difficult as in these lesions areas of extreme density and destruction of bone may be seen.

Conclusions

1. As the clinical diagnosis of osteitis deformans is not always possible, especially in the early stages of the disease, careful roentgenographic study should be made of many bones, particularly of the skull and long bones, of all patients suffering from bone deformity or bone pain.

2. The possibility of bone metastasis should be kept in mind when osteitis deformans is diagnosed in the spine and pelvis.

3. Many bones are involved by the disease process and the bone changes when seen in the skull are pathognomonic.

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Possibilities of Intra-Vaginal X-Ray Therapy, With Description of Technique*

EDWIN A. MERRITT, M. D., WASHINGTON, D. C.

THE intra-vaginal application of the x-rays is by no means an innovation in x-ray therapy. For one reason or another the method has fallen into disuse and at the present time it is the exception rather than the rule to treat intra-vaginal conditions by directing the x-rays into the vagina.

The author is cognizant of the superiority of radium in treating the cavities, but this substance is not within the reach of all and even when it is, there are probably some cases where the x-rays would be preferred—if they could be used conveniently.

Assuming, then, that the above premise is correct, it follows that the most convenient method of employing the x-rays with respect to accessability of part treated, distance, and patient's comfort, is the one to be adopted.

Any measure that offers even a modicum of assistance in the successful management of malignant disease is thankfully received, and with respect to radiant energy in general the dictum may at this time be safely promulgated that the quantity to be delivered in a given case of malignancy is that which stops just short of accomplishing more harm than good.

During the past summer the urgent need for radiotheraphy in a certain case of inoperable carcinoma of the vagina and cervix, prompted the use of the x-rays by a technique with results which apparently justify more than passing notice.

Mrs. W., age 39, was first seen by Dr. A. B. Little of Takoma Park, D. C., April 26, 1920, who recognized the condition promptly and referred her to Drs. G. Dent Townsend and E. M. Parker, Washington, D. C., for surgical treatment. Dr. Townsend's report is as follows:

"There was a profound cachexia and emaciation which was in keeping with the alleged 35-pound loss of weight during the previous five months of her illness. Vaginal examination showed a cauliflower mass involving the cervix, which bled easily and from which exuded a sero-sanguineous, offensive discharge. The anterior vaginal wall showed ulceration and induration for half its length and the posterior wall to a lesser degree. The uterus was enlarged with absolute fixation and no satisfactory opinion could be given with reference to the adnexa on account of

invasion in that region. The rectum was apparently not involved. The bladder was negative excepting for tenderness and frequency of urination which was increased by my examination. There was a rather profuse hemorrhage the day following the examination, which was controlled by a pack.

"Again in October I examined the patient and found a complete disappearance of the cachexia with a gain in weight of 25 pounds. The mass in the vagina was replaced by apparently healthy healed scar tissue, and

Fig. I.—Close up side view, showing the method of supporting the legs and the x-ray tube in position.

I considered the case inoperable and in consultation with Dr. Parker referred the case for x-ray therapy. After the first application of the x-rays I removed a small fragment of the tumor for laboratory study, and received a report from Dr. Lester Neuman to the effect that it was a "flat cell carcinoma".

the remnant of the cervix was represented by a small granulating surface corresponding to the internal os from which there was a muco-purulent discharge. The thickened walls of the cul-de-sac made examination of the uterus difficult, but it could be quite

readily found retro-displaced and normal in size. For a case that seemed hopeless in April the results so far are very gratifying."

Treatment: The patient was admitted to Garfield Hospital, May 25, 1920, and received intra-vaginal x-ray treatments from then to November 8, 1920, at varying intervals—a total of one hour and 50 minutes unfiltered x-ray from a Coolidge tube passing 6 ma. at an anode cervix distance of 12 inches, back up an eight-inch gap for 15 and 20 minutes at each treatment.

In addition to this, cross-firing through skin areas—four anterior and four posterior—was resorted to with the ordinary deep therapy technique at the usual intervals. The very definite improvement in the appearance of the growth at the time of the second intra-vaginal raying leaves no room for doubt that the malignant cells were rapidly responding to the rays directed into the vagina, as the cross-firing from without was wholly inadequate in this brief period to have excited any material change.

Fig. II.—View looking from the head toward the feet, showing the method of suspending the legs in slings and the method of taking care of high-tension wires.

The intra-vaginal treatments were followed by nausea identical

with the well-known x-ray sickness, and rather more apparent than when treatments were given through skin areas. The results were all that could be expected. There was a return to normal weight, a normal blood picture, and a general feeling of well-being.

Fig. III.—View showing how close the tube is brought in between the thighs without danger of short circuiting the high-tension wires.

As an additional factor of safety, on November 11, 1920, the patient received 1,000 mg. hours of radium applied to the interior of the uterus,—and additional treatments are contemplated. Under date of December 6, she writes from New York that she has gained an additional three pounds, now weighing more than ever before.

Technique: The apparatus required for this method of intra-vaginal raying, in addition to the usual transformer, treatment or other convenient table and treatment stand, consist of two six-inch lag screws with hook turned at one end; two small iron pulleys; one three-inch T bandage; one glass speculum of special design; a square of lead with hole to admit speculum; two roller towels, and enough rope of the kind commonly sold as "clothes line", to reach double the distance from a substantial bracket on wall

or base-board to the pulleys, which are fastened to the lag screws previously placed in the ceiling. The pulleys and screws should be so placed that the ropes when taut will clear the overhead wiring system and extend downward, forward and inward at approximately 45 degrees to the patient's knees. The patient occupies the dorsal position with the hips well elevated by sandbags suitably covered. The towels are adjusted to either leg by making a noose and passing it over the leg to support same by the full width of the towel—the free ends being tied to the ropes which are drawn through pulleys, and are then fastened securely to wall brackets, bringing the thighs at right angles to the body.

The speculum is then inserted through the lead mask into the vagina—the folds of the vaginal wall being pushed aside by dressing forceps and gauze sponge if necessary. The tail of the T bandage is brought forward over the base of the speculum and pinned or tied to the abdominal portion. The treatment stand is fitted with a cone one and one-half inches in diameter and brought to the side of the table and so adjusted that the beam of light from the filament is directed into the speculum, which should just clear the cone. The only remaining adjustment is to fasten a string to the lower high tension wire and pull it clear of the tube when it may be fastened to any convenient object.

The speculum was constructed according to the author's design by a Philadelphia Glass company. It is a cylinder of glass two and three-fourths inches on one side and four inches on the other. It has at its base a flange of glass three-fourths inch wide and the diameter of the aperture is one and one-half inches. The speculum is inserted through a hole slightly larger than its diameter in a square or lead sufficiently large to protect the perineum. The glass is approximately one-eighth inch in thickness.

Patients readily submit to this treatment and complain only of the discomfort produced by the speculum. Exposures of 20 minutes are easily borne. This method obviates the danger of accidental contact with high tension currents, permits the treatment cone to be brought practically into contact with the external genitalia and assures definite radiation to the walls of the vagina, as well as the cervix and adjacent structures. At a 12-inch distance the diameter of the intra-vaginal area receiving the full intensity of radiation is three inches. And with the formula 6x8x20-12x12, without filter, each treatment amounts to approximately 12 skin units,—using the standard for one skin unit as designated by Drs. Wm. D. Witherbee and John Remer of New York. However, the earlier

treatments in this case were administered with the idea of delivering a maximum quantity of x-rays and it was not until their article appeared in the American Journal of Roentgenology that the actual number of skin units was determined.

*—Read at Annual Meeting Radiological Society of North America, Chicago December, 1920.

Department of Technique

IT IS the purpose of this department to render a personal service to all subscribers of the Journal. In view of this fact, we hope that all of the readers may feel free to ask questions of us. If you will send these questions to the Journal office, you will receive answers to questions in the following issue of the Journal.

In order that one may have his technique properly systematized, it is necessary for him to adopt certain fundamental rules which shall govern the examination at all times. For a number of years we have adhered to the following rules in our office:

1. Plates of all fractures should be made in two planes.

2. Stereoscopic plates should be made of all heads, shoulders, wrists, sacro-iliac region, foreign bodies and chests. Others as indicated.

3. In sinus examinations, all of the sinuses should be examined as a routine.

4. In gastro-intestinal work, not less than three plates should be made of the stomach at the first examination. Others as indicated. There should be at least one plate of the colon. The opaque enema should be used as a routine in colon examinations, which should be followed by stereoscopic plates.

5. All chest plates should be made with the film and double intensifying screen, with the patient in the upright position unless the patient is extremely ill, the two exposures being made instantaneously while the patient holds the breath. The patient should not be allowed to breathe between the two exposures.

6. The dark room should be kept scrupulously clean. If chemical solutions are spilled about and allowed to dry, the chemicals contained in the solution become powdered and float about the room and will be deposited on the plates and other material, causing a fog which is hard to trace.

7. Fresh developing solution should be made at intervals not longer than two weeks when tank development is used, oftener, if needed.

8. Fresh hypo solution should be made once a week in tank development, oftener, if needed.

9. The temperature of the developing solution should be kept between 65 and 75 degrees Fahrenheit. A thermometer should be used to determine the temperature.

10. Distilled water should be used in making all chemical solutions.

Opaque Meal in the Liver Ducts

F. B. Stephenson, M. D., Denver, Colo.

MY reasons for reporting this case are its novelty and the bearing which the unusual phenomenon observed may have upon our conception of the etiology of inflammatory conditions of the liver and its ducts. I have not been able to find a similar case reported except one which is described by Carman and Miller.* In that case, however, there had been adhesions of the gallbladder to the duodenum with rupture so that the barium meal was thought to have entered the bile ducts by way of the gallbladder.

Mr. A. V. A., age 56, was referred to Dr. L. H. Wade and myself by Dr. J. N. Hall, January, 19, 1920, for roentgen gastrointestinal examination. He complained of having had stomach trouble 18 years. In January, 1916, his gallbladder and appendix were removed; no stones were found. He was said to have had a "mulberry" gallbladder. Previous to his operation he had been troubled for some years with pains across the upper abdomen but mostly on the left side, which would come on two or three times a day and last a few hours; he would be free from pain a few days at a time. He had never vomited but belched "hot" stomach contents. He was not relieved by the operation, but the character of his pain is now somewhat different. It wakes him up about daylight so that he can sleep no longer and he arises. Occasionally the pain will come on in the day time. It is epigastric in location and makes him "catch his breath". Eating or drinking relieves it and it comes on again if he goes as long as five hours without eating. The clinical diagnosis of Dr. Hall was ulcer. The x-ray examination was confirmatory but somewhat doubtful on that point, because the spastic deformity seen could be due to other reflex causes; but he was treated for ulcer with immense relief and gained 12 pounds in the year following his examination. About one month ago he began having trouble again and it was found he had stopped his dietary regimen.

In the course of this patient's original x-ray examination it was seen under the fluoroscope that the barium began to travel upward in unusual channels. Plates taken afterwards showed that it was unquestionably in the larger bile ducts at first and that it passed progressively into their ramifications. This led us to study the case with particular care and we secured a series of plates which are shown. One year later I prevailed upon the patient

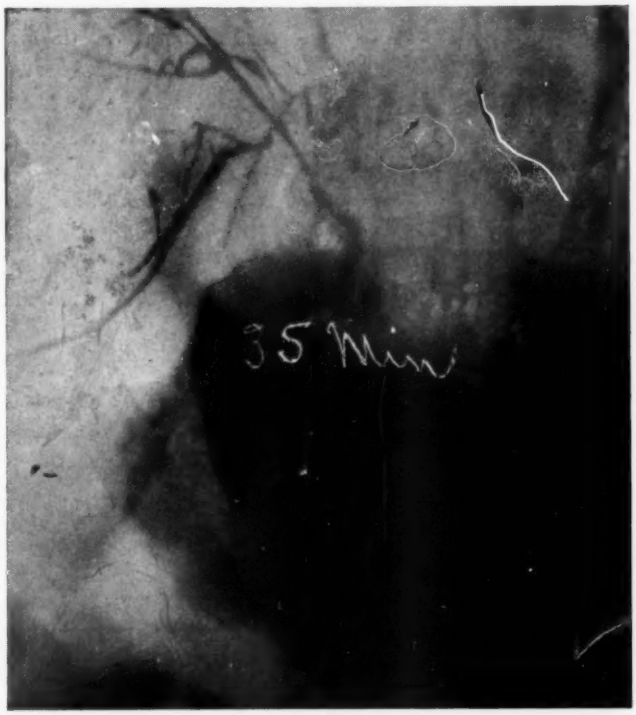
to allow me to give him a second examination and found the same condition to exist as was present the year before. It will be seen on the six-hour plate that there is present a residue in the duodenum which by some writers has been looked upon as a duodenal diverticulum and by others is considered to be a dilated ampulla of Vater. This was present on the 24-hour plate. The writer has a number of records on file showing a similar condition, but in none of these cases did the barium traverse the bile or pancreatic ducts. I have endeavored to find out whether there was a connection in this case between the common ducts and this duodenal residue, but could not do so.

It is interesting to speculate upon how a person can go along day after day with duodenal contents going up into his liver regularly, as must be the case with this man, and yet have no symptoms of infection of the ducts. While it seems impossible that the stomach contents, as they enter the duodenum, should constantly and regularly be sterile (for we know that the stomach begins to empty itself almost immediately after eating and many pathogenic organisms must at times enter the

No. 1—20 minutes after barium ingestion barium in larger branches of bile ducts.

duodenum in a live state), nevertheless, the ducts in this patient being vulnerable and yet giving no symptoms of infection would seem to point to such sterility. In many cases of ruptured duodenal ulcer there has been found to be little, if any, infection of the peritoneum, a moderate inflammatory reaction being attributable to chemical and mechanical irritation. The supposed sterility of the escaped contents in such cases has been laid to the excessive hyperacidity which attended the condition. In this case, while there had been hyperacidity it was afterwards regularly relieved by alkaline treatment and the stomach juices so neutralized could hardly be quickly germicidal. This man has pain, to be sure, but it is relieved by eating and by alkalis and is probably due to ulcer.

It is possible that following his cholecystectomy, five years ago, this man has developed a dilated common duct as has been shown to happen in many cases following gallbladder removal and that this dilatation has extended within the duodenal wall and resulted in an open stoma which offers no resistance to the backward passage of duodenal contents. The barium was found to leave the ducts



No. 2—35 minutes.

rather slowly when the patient was erect and when he would lie down it would again fill them. Is the secretion of bile so slight during stomach digestion that the ducts are practically empty? They must have been fairly free of bile into the duodenum varies considerably in the normal. The variations in the formation of the ampulla were studied with reference to this case, but they do not throw any light upon the phenomenon in question. Whether a part of this

No. 3—40 minutes. The common duct is here plainly to be seen.

in this case to allow the barium mixture to extend into the finer branches, and the secretion sluggish to permit of its remaining as long as it did. The anatomy of the common and pancreatic ducts at their point of union or opening barium was in the pancreatic ducts was not determinable. The remarkable feature of the case is that while the condition has existed at least over a year the patient at present has no evidence of hepatitis or choledochitis.

No. 5—6-hour plate. Some of the finer branches still filled.

No. 4—4-hour plate.

No. 6—One year later. Larger branches again barium filled.

The X-Ray Diagnosis of the Diseases of the Alimentary Canal

ALBERT M. PFEFFER, M. D., WICHITA, KANS.

IN 1895 Roentgen [1] announced that the salts of metals, either solid or in solution, obstructed the passage of his new rays. Within two months Dutto [2] proposed the possibility of rendering hollow viscera visible by injecting them with salts. A month later Becher [3] published a roentgenogram of a dead guinea-pig in which he had distended the stomach and a loop of small intestine with lead subacetate. Hemmeter [4] accordingly devised an intragastric bag and proposed that the bag be pushed into the stomach and filled with lead subacetate, thus enabling the shape of the stomach to be outlined on a roentgenogram. W. B. Cannon [5] of Harvard, at the meeting of the American Physiological Society in Boston, December, 1896, made the first public demonstration of the movements of the alimentary canal when he exhibited the phenomena of deglutition by feeding a goose with gelatin capsules filled with bismuth subnitrate. In April 1897, Rumped [6] rendered a pathologically dilated oesophagus visible by pouring into it 300 cc. of a 5 per cent suspension of bismuth subnitrate. To the Harvard Laboratory falls the credit of being the first to use the heavy metal salts mixed with food for x-ray purposes. Observations of gastric peristalsis were presented by Professor Bowditch [7] of Harvard at a meeting of the American Physiological Society in Washington, May, 1897. Roux and Balthazzard [8] at a Paris meeting of the Societe de Biologie, July, 1897, reported similar observations in dog and man. For their human subjects they use 15-20 grams bismuth subnitrate in 100 cc. water. They could, however, only observe the lower part of the greater curvature. In 1903 Williams [9] published the results of roentgen work on the alimentary canal comprising observations on stomach, small and large intestines. In 1905 Rieder [10] reported his thorough study of the human alimentary canal by the x-rays.

X-ray revealed much pertaining to the physiology and pathology of the gastro-intestinal tract. The passing of ingested food along the lesser curvature as observed by the fluoroscope gave W. J. Mayo [11] the suggestion for his irritation theory of the causation of carcinoma of the stomach, namely, that the constant irritation and changes of hot and cold food substances affecting the lesser curvature explain the occurrence of ulcer and cancer in that

region in 80 per cent of the cases.

While the opaque meal has since been changed from the subnitrate to the subcarbonate and the latter substituted by barium sulphate, yet the principles are the same, and all the modern achievements in x-ray diagnosis of the alimentary canal rest on the foregoing fundamentals.

General Considerations.

The x-ray diagnosis of the diseases of the gastro-intestinal tract depends upon the introduction into the alimentary canal of an opaque substance which completely fills the lumen, and observing its passage through it. The evidences obtained are direct and indirect. The direct evidences are abnormalities in contour, size, and position, viz:

Filling defects
Projections into the lumen
Niches
Diverticula
Hour glass deformities
Dilatations or narrowings
Changes in positions of organs.

The indirect evidences are abnormalities in function, viz:

Changes in emptying time.
Stasis
Spasms
Hyperperistalsis or antiperistalsis.

The different x-ray findings in the various organs under consideration in this thesis will be discussed separately with the diseases peculiar to them.

The Opaque Substance.

The opaque substance commonly used is "Barium Sulphate for X-ray Diagnosis," superseding the bismuth subcarbonate, which by its alkalinity interfered with the normal re-actions, and the still earlier bismuth subnitrate which was toxic. It is administered as meals by mouth, and as enemas per rectum. The following requirements are laid down by Carman: (12)

1. It should be more or less palatable.
2. Thick enough to hold the salts in suspension.
3. Thin enough to fill all recesses.
4. Not stimulating or neutralizing gastric secretions.
5. Not productive of early pyloric closure.
6. Must be an even, smooth emulsion, not lumpy.
7. Of definite composition to give uniform results.
8. Should be easily and quickly prepared.

The most commonly used formula for gastric and small intestinal examination is: seven ounces of chemically pure barium sulphate stirred into one pint of buttermilk made from the whole milk. Where this cannot be obtained an emulsion of mucilage of acacia and barium sulphate with water can be substituted. The amount, however, varies with the size of the individual.

The x-ray examination of the oesophagus presents a special

problem because of the rapidity of emptying. The most used is the suspension outlined by Hirsch [13] which, due to its high content of mucilage, adheres well to the walls of the oesophagus, especially to any ulcerated surface, and can be easily washed off. A unique method, described by Bassler [14] and Nines [15], consists of the introduction of a rubber tube with an inflatable bag at the end, into the stomach. This is then filled with water and pulled into the cardiac orifice. Thus the oesophagus can be kept filled with the barium meal and roentgenograms can be taken. Spangler [16] inflates the stomach with gas, in examinations of the oesophagus, thus obtaining the best view of the cardiac orifice. If a diverticulum is shown, the pocket is best demonstrated by the usual barium meal.

Preparation of the Patient.

Smithies [17] washes the stomach, gives a purgative the day before examinations, and keeps the patient on a liquid diet for 12 hours. But it is generally condemned because the normal function is masked. No catharsis is is allowed in upper tract examinations. For the opaque enema the colon is flushed previously. The patient should present himself, however, with an empty stomach. All drugs having any stimulating or inhibitory effect upon the digestive tract should be withdrawn at least 24 hours before the examination. Only where it is necessary to differentiate between spasm of reflex and of organic origin, belladonna, in the form of the tincture to tolerance, or 1-100 gr. atropine hypodermically is used at the time of examination.

The Oesophagus.

The normal oesophagus is best observed through fluoroscopy. Abnormalities of the oesophagus are:

1. Diverticula.
2. Benign strictures.
3. Malignant new growths.
4. Spasms.

Diverticula may lie anteriorly, posteriorly or laterally and should be viewed from all sides. The symptoms are: Swelling in neck, periodic emptying of putrefactive food, and gradual emaciation. X-ray findings show a shadow to one side of the lumen remaining after the oesophagus is empty.

The benign strictures usually result from irritating caustics such as phenol or lye passing down the oesophagus in attempted suicides or taken by mistake by children.

The malignant growths are made evident by the x-ray by the amount of obstruction as well as by the site of the lesion which can be easily demonstrated. A diagnosis of malignancy is made by the "bitten out" appearance of the growth and by its location at the cardiac end. At times stomach involvements may be shown.

Not infrequently foreign bodies lodge in the oesophagus, especially

in children and the insane. Portions of food, coins, fish bones, pins, plates of false teeth are the usual articles. Both diagnosis and removal are often possible by the fluoroscope.

Spasms.

Hysterical strictures arising chiefly in neurotic women at times associated with some slight abrasion or ulceration originating from impaction of a fish bone are of common occurrence. The symptoms are: difficulty in swallowing, and the "globus hystericus" are intermittent in character. Usually, reflex spasms will relax by administration of belladonna.

The Stomach.

The normal stomach varies in size and position in different individuals. Several types are recognized; the high traverse stomach of fat people, the cow horn type of medium weight, and the fish hook type common in thin individuals. There are slight changes in the normal motility of these normal stomachs. George and Leonard [18] observed that the normal stomach possesses individuality and with the same technique the same stomach will appear alike in successive examinations. Normal outline may be interfered with by pressure of neighboring organs as: distended colon, hypernephroma, enlarged duodenum, enlarged gallbladder and from the spine.

Gastric Ulcer.

The peptic ulcer is usually a circumscribed area, varying in size, situated about the pylorus, and with few exceptions involves the lesser curvature or the posterior wall. The ulcer usually becomes chronic and produces induration with deformity.

To demonstrate these ulcers the prone and lateral positions are used. The prone position shows in profile the greater and lesser curvatures, while the lateral position shows the anterior and posterior walls. Of course, proper examinations for peristalsis and general outline are made by the fluoroscope.

X-ray of stomach affords both direct and indirect evidence of gastic ulcer pathology. The direct evidence is based upon the following variations from the normal:

1. Bismuth in the ulcer crater. When found is pathognomonic, but may not often appear because of the crater being filled with secretions and food debris.

2. Passage of bismuth through the wall in perforations. Bismuth is found outside the wall of the stomach in a small pouch or pocket, usually of connective tissue. Often-times it contains a bubble of gas. Haudek in 1910 was the first to describe this phenomenon, after whom it was named, Haudek's niche.

3. Filling defect in shadow from induration about the ulcer, due to a local rigidity in the wall showing no evidence of peristaltic waves over an area usually on lesser curvature about two inches

in diameter. Repeated exposures of one-quarter second will usually produce a blurred outline of the wall due to the presence of peristalsis, but over the indurated area the outlines will be definite, because of absence of peristalsis. The fluoroscope and palpation are used for corroborative evidence.

4. Hourglass deformity: Hourglass deformities must be ascertained whether functional or organic, and if organic must be determined whether due to the induration of chronic ulcer, or due to new growth and adhesions. According to Crane the following differentiation is made between the hourglass of chronic ulcer and the new one of new growth:

Chronic Ulcer.

Hourglass, Sacculated.
Sulcus, band-like and smooth.
Connecting isthmus, eccentric nearer lesser curvature.

New Growth.

Funnel-like, broad and irregular.
Centrical, with symmetrical annular defect.

5. Pyloric obstruction, other than from new growth, cases of 24-hour residue are usually due to the following causes: (1) benign cicatrix of long duration as proven by an associated secondary dilation with hypertrophy of the stomach, and violent peristalsis; (2) new growth, differentiated from cicatrices by their own characteristic appearance, and because of short duration there is no marked dilatation of the stomach.

The indirect evidence of gastric ulcer, non-positive evidence, is based upon the following:

1. Delayed emptying time of the gastric residue by spasm of pylorus, usually after eight or ten hours.

2. Incisure on greater curvature suggest ulcer in opposite side.

3. Abnormalities of peristalsis, and tender points over gastric shadows during fluoroscopy, are of lesser significance.

Franklin W. White [19] is of the opinion that none of the signs of indirect evidence can be relied upon for diagnosis, as spasms, six-hour residue, and changes in peristalsis may be produced reflexly from gallbladder disease or chronic appendicitis or neuroses.

New Growth of the Stomach.

The technique and routine are the same as in ulcer. Fluoroscopy is used while the patient ingests the meal, and observations as to hypermotility, peristalsis, and antiperistalsis are made. Then a series of plates in various positions is taken.

The diagnosis is based upon the presence of a filling defect in the gastric shadow. In the greatest percentage of cases it is found at the pylorus, especially when early. In some cases it is found in the cardiac end.

The defect is usually annular, and in the early cases appears as an elongation of the pyloric gap. The annular appearance distinguishes this from the gastric ulcer of the same region. The filling defect when found in plates of lateral positions definitely eliminates the question of pressure de-

fects, by gallbladder, liver, etc.

The defect is usually irregular and serrated in outline. When this is present it is of pathognomonic significance. The later cases present a more extensive and more pronounced picture of the earlier ones. The canalization is extended over a greater portion of the stomach. The irregular "bitten out" outline presents now finger-like projections into the shadow.

George and Leonard report cases of carcinoma where the stomach walls were very rigid and a tubular canal extended its whole length. On the screen peristalsis appeared to be absent. In such cases although the emptying time is very rapid the patient can eat but very little at a time.

The hour glass appearance resulting from new growth should be differentiated from the one resulting from chronic ulcer (vide supra).

In conditions of degenerating chronic ulcer a roentgenogram presenting carcinoma appearance is of greatest significance, as a resection rather than a mere gastroenterostomy is to be performed.

The negative plate with the proper technique is very positive in eliminating carcinoma.

Rarer Stomach Lesions.

D. C. Balfour [20] reports a case of polyposis of stomach which becomes quite evident by x-ray methods. A number of cases of polyposis of the stomach with accompanying roentgenograms have been reported also by George and Leonard. George W. Holmes [21] calls attention to the presence of pedunculated tumors of the stomach easily diagnosed by fluoroscopy. He reports two cases, one having been diagnosed pathologically as a fibrosarcoma, the other as lymphangio endothelioma. He remarks that Fenwick reported the only other case in the literature of fibrosarcoma of the stomach. Von Posvic [22] observed that in syphilis of the stomach the administration of antispasmodics causes an unusual discomfort, nausea, and depression.

Albert M. Cole [23] of Indianapolis reports a case of a diagnosis of hourglass stomach by x-ray methods after four days' administration of 80 to 120 minims of the tincture of belladonna, which was found to be spasmodic in origin and was due to a diseased appendix.

[24]. He also reports a rare case of hourglass stomach with adhesion of the second portion of the duodenum to the cardia, and communicating with it through a perforated ulcer. The condition was diagnosed by observing the process of filling on the screen.

A. F. Tyler [25] reports a case of a jejunal ulcer at the site of a gastroenterostomy performed four years ago and the Murphy button having been retained since. He adds the interesting remark that the opaque meal and a course of bismuth subnitrate proved to be of therapeutic value.

Cases of diaphragmatic hernia have been reported by Andrew J. Grant [26] as a result of gun shot wounds. He described a case of soldier who suffered pain of any description immediately after taking food, and had been treated for many months as a case of gastritis. At an x-ray examination it was found to be a diaphragmatic hernia of the stomach reaching to the level of the third rib. A number of cases following gun shot wounds have been reported in the war literature. In children it occurs congenitally. They are mostly diagnosed by x-ray.

The Duodenum.

The duodenal ulcer—Cole bases the diagnosis of duodenal ulcer by x-ray methods upon the following:

1. If normal, the first portion of the duodenum can always be demonstrated on the plate with characteristic shape and smooth outline.

2. Ninety-five per cent of all duodenal ulcers occur in the first portion.

3. A constant defect in the duodenal cap on the plate means a pathological condition, either; (a) ulcer, (b) adhesions due to cholecystitis, or anatomical or accidental abnormalities as pressure from adjacent organs.

4. Any duodenal ulcer other than a simple erosion will distort the outline of the barium mass.

5. With the exception of the minute recent ulcer, a normal "bulbus duodeni" rules out a chronic indurated, or surgical, ulcer. It, however, may have a minute recent perforated ulcer.

Conditions interfering with the demonstrations of the first portions of the duodenal are: (a) pyloric spasms; (b) pressure from adjacent organs such as enlarged and distended gallbladder, enlarged lobes of the liver, etc.; (c) spasms due to chronic appendicitis, obstructive conditions of the intestines.

At times a number of plates must be taken in various positions.

George and Leonard state that an incisura opposite the ulcer is found in the duodenum in cases where the musculature and connective tissue have become involved.

Dr. Wm. J. Mayo [27] published a number of cases of duodenal ulcers of the anterior wall showing merely a pin point defect on the mucosal surface with some mucous membrane heaped upon it. But the amount of callus and induration is, however, much greater, and is therefore shown on the plate under the proper technique. Carman of the Mayo Clinic lays less emphasis upon the direct evidence in duodenal ulcers, but employs mainly the indirect evidence based upon a major and minor group of signs. The major group of signs consists of evidence of hyperperistalsis, six-hour gastric residue, and demonstrable diverticulum of the duodenum. These signs are worth more than 95 per cent in the diagnosis of

duodenal ulcers, according to Dr. Carman. His group of minor signs includes hypermotility, hypertonus of the stomach, pressure tender points, lagging of bismuth, and deformity of the outline of duodenal cap. He has, however, later on admitted laying chief emphasis upon the direct evidence found in the change of the outline, recognizing it as the most important sign.

Other abnormalities of duodenum—Payne and Thayer [28] report five cases of barium stasis of six hours and longer, one case as long as 48 hours which could have easily been interpreted as penetrating ulcer or diverticulum, but proved to be a dilated and patent common duct resulting from a general visceroptosis and relaxation of the ampulla by previous passages of gall stone.

Case [29] likewise calls attention to the fact that barium stasis in the common duct and in the smaller duct of Santorini in certain cases of abnormal dilatation or patency.

W. A. Downes [30] reports a case of giant duodenum in a child four and one-half years old. Weighed six pounds at birth, 29 pounds on admission to hospital. Had frequent fits of vomiting at intervals. At operation the duodenum was found enlarged to the size of the stomach. The entire length was involved. The enlargement stopped abruptly where the gut passed under the superior mesenteric artery. The condition was diagnosed by x-ray.

Pauchet [31] reports a case of dilatated duodenum with kink and dilatation of the last loop of the ileum. X-ray showed an enlarged duodenum emptying with difficulty. A last loop of ileum emptied after 30 hours. The condition seems to be due to ptosis with traction on mesentery and vessels causing stasis and chronic toxæmia.

Vanderhoof [32], Bloodgood [33] and Kellogg [34] called attention to a condition of angulation of the duodenum due either to mesenteric bands pulling it to the liver, or to an exaggerated visceroptosis, resulting in an obstruction. The clinical picture is vomiting, pain in the right hypochondrium, obstinate constipation with almost colorless stools, and vague toxic symptoms. The roentgenological findings are:

1. Marked retention in duodenum.
2. Writhing and twisting of the duodenum.
3. Reversed peristalsis.
4. Tenderness at the angle of Treitz.
5. Dilatation of duodenum.
6. Some cases will be relieved by change of position.

H. P. Ritchie [35] reviews 75 cases of diverticula discovered roentgenologically, one case being a pseudo diverticulum caused by sacculation of an ulcer scar. He also reports a case of his own where a very large diverticulum

was found in close proximity to an ulcer in the first portion of the duodenum.

Gallbladder

The technique is the same as for soft tissue work and the value of the plates depends upon their completeness in showing the greatest possible degree of detail. Usually no catharsis is advised as the resulting gas is more confusing than possible fecal concretions. With a small cone pointed obliquely downward parallel to the under surface of the liver, so that the under surface appears as a clear cut line, the gallbladder can usually be detected. Stereoscopic plates may be taken. The plates should show the entire region between the eleventh rib and the crest of the ilium. Along with the examination of the gall bladder, an entire set of plates of the gastro intestinal tract should be made for the demonstration of bands of adhesion, or for other concomitant lesions.

Cholelithiasis: There are three types of stones: (1) calcium stones, they usually show easily; (2) cholesterine; (3) mixed, nucleus of one with coating of the other.

George and Leonard state that with the modern technique, 85-90 per cent of cholelithiasis can be demonstrated on the plate. At times the superimposed plates are matched together thus intensifying whatever evidence cannot be recognized otherwise. Lantern slides made of superimposed roentgen plates may some times accentuate and bring out details. A magnifying glass may aid especially in bringing out the faceted side of a calculus.

Identification of the gallbladder aids materially in detecting calculi. The shadow cast by the long periphery of the stone makes it visible, explaining the fact why only one of a series of plates shows the stone better than all the rest.

Biliary calculi may be confused with: (1) fecal concretions; (2) calcified mesenteric glands; (3) costochondral ossifications; (4) stones in kidney and liver; (5) food in the duodenum or colon at hepatic flexure.

The clinical history with characteristic gall stone symptoms does not always agree with the x-ray diagnosis.

Small Intestine.

Pathological conditions demonstrable by x-ray of the small intestines are: (1) malpositions, either congenital or acquired; (2) functional diseases; (3) organic diseases, ulcer, new growth; (4) displacements, leading to diagnosis of enlarged spleen, kidneys, tumors (extraintestinal), aneurysm or enlarged mesenteric glands.

Exposure must be very short as the intestine is constantly in motion.

Stasis in the small intestine is diagnostic of obstruction, and may lead to the diagnosis of various mechanical causes.

Various intra-abdominal herniæ may be easily diagnosed. Many

reports have been made by various roentgenologists of stasis at the lower end of the ileum due to Lane's [43] kink. The symptomatology of Lane's kink often simulates appendicitis in causing pain and tenderness about the site of the appendix.

Adhesions causing stasis can often be diagnosed but x-ray only must not be relied upon.

Ulcer of the jejunum has been studied by Carman, and was found in a definite percentage of the cases. These occur chiefly at the site of a gastroenterostomy.

Diverticula.

Diverticula in the small intestine are not as common as in the large. Meckel [37] was the first to point out that disturbances in the involution of the omphalomesenteric duct may lead to the formation of a diverticulum near the ileocecal valve. King [35] reports two cases where umbilical tumors were found directly communicating with Meckel's diverticulum.

In new growth of the small intestine there is obstruction, filling defect, and dilatation of the proximal portion where it simulates large intestines. It is differentiated by the characteristic shadow of the valvulæ of the intestine. Adhesions obstructing the lumen will simulate new growth, but are most apt to occur in the right lower quandrant in connection with appendicitis and diseases of pelvic organs.

H. G. Sloane [38] after reviewing 50 cases in the literature, reports one of his own of a cystic degeneration of the small intestine diagnosed by x-ray.

Appendicitis

Pfahler [39] bases the diagnosis of appendicitis upon the following signs:

1. Localized tenderness—most valuable sign, elicited either by direct palpation with the gloved hand or by a (distinctor), tenderness may be movable by moving around the appendix. When appendix is invisible palpation is made of the cecum.

2. Demonstration of the appendix. Case [40] reported demonstrable appendices in 273 out of 763 cases. George and Gerber [41] visualized it in seven out of every ten. George and Leonard state that in every case where the lumen of the appendix is not obliterated the barium in buttermilk will fill the appendix and render it visible. They use 90 grams of bismuth or equivalent in barium in a pint of buttermilk. Case emphasized the horizontal position and the taking of front and back plates. Sometimes a retrocecal appendix may be shown by a lateral oblique position.

3. Fixation: Appendix found to be immovable may be bound up by adhesions to various adjacent organs.

4. Position: Normally downward. Where otherwise is probably due to inflammatory products.

5. Kinking or angulations.

6. Constriction and dilatation or irregularity in lumen.

7. Abnormal retention.

8. Incompetency of ileocecal valve seen by opaque substance regurgitating through it into the ileum, signifies reversed peristalsis.

Other roentgenological evidence of pathology in the right lower quandrant is:

1. Enteroliths in cecum, demonstrated in cases by Stamm and Pfahler, gave rise to pain and recurrent diarrhoea.

2. Adhesions of cecum to rectum caused symptoms of chronic constipation with constant desire for rectal expulsion.

3. Carcinoma of cecum—gave roentgenological localized tenderness in addition to the filling defect. It is differentiated from appendiceal abscess by its characteristic serrated outline.

4. Psoas abscess: Simulates chronic appendicitis by its local tenderness, but the normal roentgenological findings lead to an examination of the spinal column and to the diagnosis.

6. Urinary calculus: Roentgenological findings usually determine the diagnosis.

Hertz [42] recommends that a screen examination of the appendix should always be made before the opaque substance is administered to determine the presence of fecal concretions.

The Large Intestine.

For examination of the normal colon and for stasis the usual meal is employed, but for particular colon pathology the enema is used. The opaque enema is passed into the large intestine through a soft rectal tube inserted about two inches. The container should never be higher than three feet above the patient. Following are the conditions diagnosed:

1. Constipation: Bismuth is found after 48 or even 96 hours after the meal. The diagnosis of the chronic or spastic colon can easily be made by the appearance of the shadow. Where stasis is due to mechanical obstructions the cause can usually be located.

2. New growths: Appear as distinct and permanent filling defects usually annular or funnel-shaped with proximal dilatation. Swartz observed that frequently a growth will not offer obstruction to the meal, but will obstruct the enema. He explains this phenomenon by the fact that the growth has adapted itself to the natural direction of the stools and became funnelized.

The fluoroscopic observation is important, as tumors can often be palpated at the place of obstruction to the enema. Care must be taken not to confuse with some normal pressure defects due to spine or diverticula.

3. Adhesions: Produce effects similar to those of new growths and must be differentiated by the history. The hepatic flexure is

one of the most frequent locations for such adhesions resulting either from gallbladder lesions, or from the congenital Jackson's [44] membrane. Albert M. Cole [45] reports a case of pericolitis sinistra or a band of adhesion at the splenic flexure corresponding to the Jackson's membrane. The appendix region is another favorite location for bands. Postoperative adhesions in pelvic diseases may cause distortion of normal outline and obstruction.

4. Displacements: May be caused by enlarged intra-abdominal organs or tumor. A pneumoperitoneum will often help to diagnose.

5. Colitis: Mucous: Can be demonstrated by a coating of bismuth remaining after the passage of the meal, the coating adhering to the mucus on the walls.

The ulcerative colitis is demonstrated similarly.

Lawrason Brown and Homer L. Simpson [46] report analyses of 175 cases examined by x-ray for tuberculosis colitis. The chief criteria are hypermotility and filling defects. These conditions could not be diagnosed otherwise. Of the 175 cases 44 were positive, 28 of the 44 were operated upon and in 27 the diagnoses were confirmed.

6. Diverticulitis: By the aid of x-ray this condition has been diagnosed quite commonly. Multiple diverticulitis is found in the descending colon and sigmoid shadows occurring in groups and under the screen can be manipulated to show their relation to the wall of the bowel. They usually retain the opaque substance for four or five days. Case reports one with retention of 16 days. Diverticula will often cause difficult problems to the surgeon. George F. Straub [47] reports a case where a diverticulum of the descending colon caused pressure upon the left ureter and produced intermittent hydronephrosis, the patient emptying a large amount of urine after the evacuation of the diverticulum which took place regularly every five days. Straub diagnosed the condition by the opaque enema.

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Journal of Radiology

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The May Issue

THE May issue of the Journal will be a special Boston number and will contain interesting material relative to the city of Boston, featuring points of interest to medical men, especially. There will also be the usual amount of scientific material, together with a brief historical survey of the part the Boston medical profession has played in medical history. A biographical tribute will be paid the late Walter J. Dodd and Oliver Wendell Holmes, and a resume of the work done by W. B. Cannon, on the examination of the gastro-intestinal tract by the use of opaque substances, will also be given. These facts alone, speak for a number which will be extremely interesting to every physician whether he is engaged in radiology or not.

The Boston Meeting

A GREAT deal of interest is being manifested by the members and friends throughout various parts of the country in the meeting which is to be held at Boston, June third and fourth.

The matter of hotel accommodation is one to which we wish to call your attention at this time. We are just in receipt of a letter from the American Medical Association saying that we would probably get quicker hotel reservation by addressing Dr. Stephen Rushmore at the Boston Medical Library, 8 The Fenway, Boston 17, Massachusetts. Dr. Rushmore has charge of the hotel reservations for the American Medical Association and those who wish to stay over for the two meetings would do well to write at once for reservation.

The Radiological Society will meet at the Copley Plaza Hotel.

Department of Technique

THE editors of the Journal feel that a department of technique would be especially appreciated by the subscribers. The purpose of this department is to take up the actual routine which is necessary for successful diagnostic and therapeutic work. It is the hope of the editors that all subscribers will use this department and in order to make this possible, we shall welcome any questions which you wish to have answered regarding any points in technique. If you will address these questions to the Radiological Publishing Company, 511 City National Building, Omaha, they will be taken care of.

Intra-Vaginal Treatment

DR. MERRITT has called attention on another page to a method which he has devised to give x-ray treatment intra-vaginally. We want to call special attention to the technique mentioned by the doctor as we feel that this is a step in advance and overcomes much of the difficulty which has previously been experienced in attacking cancer of the cervix and vaginal wall with the x-ray. Of course,

if one has access to both radium and x-ray, the radium can easily be used intra-vaginally. The same results can be obtained by pointing the x-rays through the speculum, as described elsewhere by Merritt.

THOSE who have not yet made arrangements for the summer meeting at Boston may find it advantageous to get in touch with the Harlan-Spears, Tours. These people will run a Radiological Society section, leaving Chicago, Wednesday evening, June 1st, via the Michigan Central, as a part of the American Medical Association Excursion. A number of members of the Radiological Society have already registered with Harlan-Spears. The itinerary furnished appears interesting and offers an excellent vacation trip, while providing excellent accommodations for the summer meeting.

Correspondence

BECAUSE of numerous inquiries I have received concerning the application of an erythema skin dose (E. S. D.) with our domestic apparatus I feel that an explanation is necessary.

Using the same make transformer and otherwise like conditions as focal distance of 35 cm., 5 milliamperes, 100 kilovolts, 10 mm. aluminum filter. we must be absolutely certain that the voltage is determined by a sphere gap and that the milliamperemeter has been tested with a control instrument.

The science of physics speaks always in linevoltages, while the clinician, especially in Europe, speaks of peak or maximum voltages. Since the most penetrable radiations depend on the highest or peak voltage, it is really correct to use peak voltage measurements. They may be obtained by multiplying line voltage with 1.4. For instance, 100,000 volts measured by our indicators means 140,000 peak or maximum voltage. This was suggested by Dr. Coolidge in a recent interview.

Having determined the accuracy of the measuring instruments we must next proceed to obtain the erythema skin dose. We began with a line voltage of 80 Kv. equal to 107.5 max. Kv. and found that the duration of exposure to obtain an E. S. D. was three hours. Using a peakvoltage of 126 Kv. equaling a line voltage of 90 Kv. we obtain an E. S. D. in about 60 minutes. Using a peakvoltage of 140 Kv. or 100 Kv. line voltage, the time of exposure is 50 minutes. Therefore, it becomes necessary that each therapeutist determine the duration of application of x-rays to produce an E. S. D. for his apparatus.

We are at present making investigations with an intensimeter of Furstenau placed at my disposal through the kindness of the Victor X-ray Corporation. Using a current of 126 peak voltage and a load of 5 milliamperes, focal distance of 35 cm., a filter of 10 mm. aluminum and 6 mm. of sole leather, we obtain six Furstenau units per minute. The E. S. D. is obtained in 60 minutes, hence it takes 360 F. to obtain an E. S. D. The same measurements, of course, should be obtained under like conditions. Hence, if another machine produced 8 F. in 1 minute under like conditions, it would mean that an E. S. D. would be obtained in 360 divided by eight equals 45 minutes.

However, until we have a measuring instrument it will be necessary to determine the E. S. D. under always like working conditions.

HENRY SCHMITZ, M. D.

Abstracts and Reviews

The purpose of this department is to furnish its readers a succinct epitome of current interesting articles and books. We will be glad to review articles which have been presented for publication or any manuscript or book sent us.

The Roentgen Diagnosis and Localization of Peptic Ulcer, R. D. Carman, California State J. Med., XVII, 378.

THE medical and surgical treatment of peptic ulcer has long been a subject of controversy; the method of treatment depends on proper diagnosis. The surgeon has the advantage in that he can see, feel, and demonstrate the presence of ulcer before he decides on the method of operation. Few medical men can be certain of the condition, unless the ulcer can be demonstrated by roentgen-ray. Treating ulcers diagnosed on clinical findings and treating those diagnosed on roentgen findings are different matters. Although the roentgen-ray is not infallible and may not distinguish simple from malignant ulcers, it can point to the fact that a lesion is present and frequently is the means of earlier diagnosis.

The general opinion that duodenal ulcer has a more exact symptomatology than gastric ulcer may be due to the fact that it is about four times as common as gastric ulcer. Moreover, many patients may have learned the ulcer symptoms from former examinations, and thus influenced, recite a history typical of ulcer.

The localization of peptic ulcer has an importance apart from diagnostic accuracy. In 245 cases diagnosed gastric ulcer by the roentgen-ray and operatively confirmed during 1918 and 1919, 33 (14.47 per cent) were found to be carcinomatous. Twelve (8.6 per cent) of these were not recognized as malignant before operation. Only six primary malignancies were found in 4,500 operations on the doudenum. Since diagnosis is the basis of treatment, diagnostic separation of gastric from duodenal ulcer should be of invaluable assistance to the physician from the standpoint of prognosis.

Three thousand eight hundred and ninety of 23,598 patients examined at the Mayo Clinic from July 1, 1918, to January 1, 1919, complained of gastric symptoms sufficient to warrant roentgenologic study. Operation was done in 343 of 528 cases diagnosed peptic ulcer and diagnosis was confirmed in 337 (98.21 per cent). Four hundred and seventeen of these were diagnosed duodenal ulcer by the roentgen-ray and 111 gastric ulcer, a ratio of 4 to 1. Two hundred and fifty-five of the 417 cases diagnosed ulcer were operated on; in 246 (96.47 per cent) the diagnosis was confirmed. Operations were performed in 88 of the 111 cases diagnosed gastric ulcer; in 84 (95.45 per cent) diagnosis was confirmed. The discrepancy between the percentage of confirmed peptic ulcer (98.21 per cent) and the confirmation of duodenal (96.47 per cent) and gastric ulcers (95.45 per cent) independently, is due to the incorrect diagnosis in two cases of gastric ulcer and five cases of duodenal ulcer.

There were 21 cases in which a definite pathologic condition was shown, but accurate localization was impossible. The final diagnosis in the 18 patients brought to operation was gastric ulcer, four; duodenal ulcer, three; gastric and duodenal ulcer; one; cancer of the stomach, eight; cholelithiasis with marked adhesions, one; lump of questionable nature in the pyloric muscle, one.

Sixty-seven cases were diagnosed "indeterminate", which signifies that from a roentgen-ray standpoint it is impossible to express either a negative or a positive opinion. Twelve of these were operated on with findings as follows: duodenal ulcer, five; gastric ulcer, one; cholecystitis, two; cholecystitis with stones, one; cancer of the stomach, one; lesion at ring, one; nodule in the liver, one.

Exploration of the stomach and duodenum was done during operation for various abdominal conditions in 351 of 3,105 cases diagnosed "negative stomach and duodenum." The diagnosis was confirmed by the surgeon in 336, or 95.76 per cent, of the cases.

Deformity of the luminal contour, either organic or spasmodic, is the principal roentgenologic sign of disease of the digestive tract. It reveals not only the lesion, but also its location, size, and often its character.

Four types of gastric ulcer may be distinguished at operation:

1—Small mucous erosions and minute, slit-like ulcers.
2—Pentrating ulcers with relatively deep craters.
3—Perforated ulcers, with or without the production of accessory pockets.
4—Carcinomatous ulcers.

The roentgen-ray signs of gastric ulcer may be divided into three groups:

1—Direct signs (pathognomonic)
  (a) The niche.
  (b) The accessory pocket.
2—Indirect signs (diagnostic).
  (a) Organic hour-glass stomach.
  (b) Spastic manifestations.
    1—Spasmodic hour-glass stomach.
    2—Gastro-spasm.
3—Corroborative signs (not diagnostic).
  (a) Retention from the six-hour meal.
  (b) Gastric hypotonus.
  (c) Alterations of peristalsis.

The niche is a bud-like projection from the barium-filled stomach and is an index either of a penetrating or of a perforated ulcer. The accessory pocket is a pouch-like excavation ranging in diameter from 1 to 5 cm. Both niche and pocket are obviously signs of advanced ulcer.

Organic hour-glass stomach is an occasional sequence of penetrating or perforated gastrict ulcer. Roentgenologically it can be distinguished from the spastic type of hour-glass stomach. It is persistent at all examinations, constant in situation, and remains unaltered after the patient has been given an antispasmodic to physiologic effect.

There are two types of spasmodic hour-glass stomach, the intrinsic and the extrinsic. For the differentiation of intrinsic and extrinsic spastic deformity tincture of belladonna is prescribed. Belladonna or atropin will not differentiate spasmodic and organic forms of hour-glass stomach, but they will differentiate intrinsic and extrinsic spasm.

A distinct residue in the stomach from the six-hour meal is seen in 55 per cen of he gasric ulcer cases. Practically 90 per cent of all gastric ulcers occur in he vertical portion of the stomach above the incisura angularis. The retentions which they produce have been assigned respectively to pylorospasm excited by the ulcer, to impairment of peristalsis, and the hypotonus.

Gastric hypotonus, as shown by sagging and expansion of the lower gastric pole is a frequent accompanimen of ulcer. Hypotonus alone possesses little significance, but if it does not accord with the habitus of the patient, the possibility of an ulcer should be considered.

The variations of peristalsis met with in gastric ulcer include weak peristalsis, hyperperistalsis, absence of peristalsis from the ulcer-bearing area, and anti-peristalsis. None of these is peculiar to ulcer, but all of them are more or less suggestive of a gastric lesion.

Differentiation of ulcer and cancer is rarely difficult, roentgenologically. Usually ulcers project from the gastric contour, while in carcinoma the growth with its resultant irregularity extends into the gastric lumen. In border-line cases, in which carcinoma cells are found in the ulcer, differentiation may be impossible.

An ulcer crater, with a base of extreme size, is to be suspected of malignancy. A niche 3 cm. or more in diameter is likely to show microscopic signs of carcinoma.

Fully 95 per cent of duodenal ulcers are found in the first 4 or 5 cm. of the duodenum, usually on the anterior wall. Judd is impressed with their frequent multiplicity.

The roentgenologic indications of duodenal ulcer may be classified as follows:

1—Direct signs.
  (a) Deformity of the duodenal bulb.
  (b) Duodenal diverticulum.
2—Indirect signs (diagnostic).
  (a) Gastric hyperperistalsis.
  (b) Gastric retention from the six-hour meal (the combination of hyperperistalsis with gastric retention and a normal gastric outline is diagnostic of duodenal ulcer with obstruction).

Deformity of the duodenal contour stands first among the roentgenologic signs of diagnostic value. The deformities more or less characteristic of duodenal ulcer may be due to (1) general distortion, (2) a niche, (3) an incisura, (4) a diminutive bulb, (5) an accessory pocket, or (6) a diverticulum. All these deformities are typical and pathognomonic of ulcer.

Hyperperistalsis consists of three or more waves running along the stomach on both curvatures. The phenomenon of hyperperistalsis is not limited to duodenal ulcer, for it may accompany disease of the gallbladder or appendix, or be seen normally in the hypertonic stomach.

Technique for Removal of Foreign Bodies Under Direct Fluoroscopic Guidance, L. W. Grove, M. D., Atlanta, Ga. Annals of Surgery, March, 1921.

THE following method was accepted as the best by long experience in the army. While chief of the Surgical Service, Base Hospital 202, Orleans, France; and while associate chief of service, General Hospital 41, Staten Island, New York, this method was used 485 times without a failure. The usual dark fluoroscopic room and table, a sharp-pointed metal indicator, a head-light for the operator and a screened light for the anesthetist were used.

A preliminary study with the fluoroscope is made to determine the course of action. Exact localization is done in the following manner: With the patient asleep the foreign body is localized between the tube and screen in the direct ray. The metal indicator is placed directly over the foreign body, the tube is shifted in the long axis of the field, and the relative rate and distance of movement of the foreign body and indicator are noted. The indicator is raised or lowered until by the rate and distance it can be determined that the body is in the same plane as the indicator. Thus the depth can be determined. This is very similar to one of the methods of localization described in the army manual and used by some of the roentgenologists in their service experience.

In addition to the exact localization, at the same time a skin incision is made and a heavy jaw forceps forced through the tissues until the foreign body is reached and seized. It is removed and the wound sutured or drained.

The forceps can be introduced at right angles in the plane with the foreign body. But if that is impossible, in the hands of the expert, the foreign body is soon reached by learning the technique described.

The 485 extractions covered occurred in the following locations: Pericardium, three; lung and pleural cavity, twelve; bone and joint, fifteen; soft tissue, 455. In the pericardium and neck open dissection is best. This is the same, only dissection is done under guidance of the eye. In the lung, extraction was done by producing a pneumothorax. Normal intrathoracic pressure is maintained and less hemorrhage results. Drainage tubes can be placed in abscess cavities at the same time. In a position where the blind method seems unsafe, the open can be combined with it. Foreign bodies in the brain were not treated in this way.

E. W. ROWE, M. D.

Roentgenographic Studies of Bronchietasis and Lung Abscess After Direct Injection of Bismuth Mixture Through the Bronchoscope. H. L. Lynah, M. D., and W. H. Stewart, M. D., New York, Annals of Surgery, March, 1921; page 362.

DR. STEWART'S discovery of the use of bismuth in the study of the bronchial tree was made, as many others made it, accidentally about 1915. Gradually it was learned that bismuth could be introduced without any serious difficulty. But Dr. Lynah in 1920 was the first to attempt to outline lung cavities by the injection of opaque substances through the bronchoscope. These two cases, with three others, are fully reported with the following important deductions:

1. Bismuth mixtures can be injected into the bronchii and lungs of a living patient without danger.

2. The injection of an opaque substance into the lung of the living patient will open an enormous field of usefulness in the study of cough, the expulsion of substances from the lung, and lung drainage. Bronchial structures and lung cavities can be outlined and will aid the surgeon.

3. A definite lung abscess is seldom seen bronchoscopically. Pus is seen coming from a bronchus when the abscess may be around the corner. An injection of bismuth mixture or some other opaque mixture will clear up this error.

4. Bismuth, when it enters the abcess cavity, is recognized by its metallic lustre. When it is in tubular tissue it is a dull opaque.

5. Eight cc. of bismuth subcarbonate in olive oil, one or two parts, was used. The mixture is rendered sterile by boiling.

6. The injection should be made slowly and not by squirts, to avoid soaking the surrounding lung tissue.

7. It seems from these preliminary studies that cough and cilia are not the only means of expelling secretions.

8. Although the bismuth was injected for diagnostic purposes, it seemed to have a therapeutic benefit to the five patients upon whom tried. No harm was done.

9. Fluoroscopy was important, but stereoroentgenographic examination was found the best way to localize the cavitations.

10. Experience shows that the roentgen examination should be made almost immediately after the removal of the bronchoscope, otherwise the patient, in a fit of coughing, will remove such of the bismuth from the involved lung.

E. W. ROWE, M. D.

The Thyroid and Its Diseases. Charles H. Mayo, Rochester, Minnasota. Surgery, Gynecology & Obstetrics, March, 1921.

MORE is known of this gland than of any other. Kendall has isolated the chemical compound causing the toxicity. He has prepared it synthetically. Plummer, Boothby and Sandiford have shown by 18,000 tests that hypothyroidism lowers the metabolic rate and that hypersecretion raises it.

Two marked differences in hyperthyroid cases are noticed. There is the type arising with adenoma, or upon long-standing goiters, often without exophthalmos. This type is common and occurs at about an average age of 43, coming to operation at 48. The other type comes at 36; exophthalmos occurs early, 50 per cent in a few months and 90 per cent in two years. The epinephrin test is not reliable and is often dangerous. Adenomata with hyperthyroidism average about 17 to 20 per cent of all cases of goiter with hyperthyroidism. Testing the metabolic rate is the most accurate method.

The thyroid gland is made up of a mass of encapsulated alveoli held together by a strand of connective tissue. The secretion of the gland can escape only by pressing it through the glands that produce it. In exophthalmic goiter there is no retention of secretion. In goiter of adolescence or simple goiter, retention may occur. The administration of iodine in simple goiters is beneficial.

Few patients with exophthalmic goiter make good recoveries without operation. Others make partial recoveries, with damaged hearts, kidneys, etc.

The elaborate preparations for operation are justified by the lowering of the mortality rate. A patient with a metabolic rate of plus 66 and caught on a subsiding curve is a better risk than one with plus 66 on the ascending curve.

With x-ray treatment, remission may occur just as remissions occur without treatment. Our experience has been failure or but temporary benefit. It is possible that the ray treatment may destroy the gland and product hypothyroidism. It is difficult to regulate the dosage, and its use adds to the difficulties of operation. It is to be hoped that radiotherapy may be developed into a safe and effective method of securing a cure or relief in preparation for surgery.

Operation is usually done under ether anesthesia. In 1919, 1704 of 2205 operations were under ether, 135 novocain, and 366 by combined methods. The death rate has steadily lowered in 20 years. Patients are coming earlier to operation. Only 20 per cent came in late stages. Selection of cases has lowered the mortality as much as the surgeon's skill. Mortality varies from 0 to 3 per cent in various groups.

E. W. ROWE, M. D.

Compression Fracture of the First Lumbar Vertebra with Delayed Symptoms, Rudolph V. Gorsch, M. D., New York City.

MANY back injuries are passed off without serious consideration. It seems sufficient that they be called "sprains," "arthritis," or contusions. Even when roentgenograms are made the mistaken diagnosis frequently results. The x-rays offer the only positive means of making an early diagnosis. Late diagnosis months or years afterward can be made easily. Roentgenograms are typical and distinctive. It is inferred that more cases should be examined properly by the x-ray, the spine being taken in small sections in both lateral and antero-posterior positions.

E. W. ROWE, M. D.

X-ray Bulletin, Treasury Department, U. S. Public Health Service, A. J. Paccini in charge.

A BRIEF review of several issues of this bulletin is worthy of consideration. One issued January 15, 1921, and one February 15, 1921, have been carefully read. The first contains a full and concise review of "Technique and Interpretation of Roentgenograms of Tuberculosis and Complications", by Howard E. Ashbury, M. D., F. A. C. S., Baltimore. This gives us an individual's technique and his own way of making the interpretation. There are few places where one may go for this information. The remarkable thing is that all of it is so well standardized that there will be little ground for criticism. Such matters are fast reaching the stage where they might be introduced in text-book style and remain the model for all teaching. Major Ashbury is thorough and exceedingly systematic. He gives up his own technique for making the stereoroentgenograms, his routine study of the plates and his manner and basis of interpretation, the different diagnoses, and in a full and complete summary comments on rules for use in diagnosis. A few samples: "When tuberculosis of the parenchyma is present to the extent of giving physical signs, it will be shown in a good x-ray plate as groups of tubercles with thickened bronchial tree markings leading from the hilus out to the area involved like a spray of goldenrod." "When tuberculosis does exist, the characteristic roentgenographic tubercle will appear somewhere in the field." "The tendency to speak of the bases of the lungs as non-tubercular area is a convenient way to consider base lesions, and will usually react in the right direction, but it is not infallible."

"Finally, the roentgenologist is safer when he describes the lesions and groups the possibilities and permits the clinician to diagnose the case. The clinician is not justified in making a definite diagnosis from the x-ray plate alone." "It is thought that the roentgenologist in his report should describe the changes in the lung, mention the location of the lesion, but permit the clinician to make the diagnosis."

A second article by Dr. Charles Eastmond of Brooklyn, New York, details in a careful manner his technique for examining the appendix, the direct and indirect evidence which he considers fully and logically. Among the many good points mentioned are: "The term pathological appendix is selected in preference to chronic appendicitis because the term appendicitis suggests that there is still an inflammatory condition existing; whereas the term pathological appendix merely means that there has been a pathological process which has brought about certain abnormal changes in the organ. The existing pathological condition may be quiescent and productive of no symptoms, either local or remote, or there may be changes of function in adjacent parts of the gastro-intestinal tract, without the presence of any local clinical manifestation of disease."

"Direct evidence consists of:

1. Lack of homogeneity of the appendiceal lumen.
2. Irregularities of lumen.
3. Abnormal fixation.
4. Tenderness of appendix upon palpation.
5. Abnormality of form in the way of angulations.
6. Retention of contents beyond the emptying time of the cecum.

"The indirect evidence is based on:

1. Adhesions of the terminal ileum.
2. Abnormal fixation of the cecum.
3. Functional disturbances."

"About 90 per cent of all appendices may be rendered visible."

If any reader is anxious to secure in condensed form the latest review of "The Principles of the Therapeutic Application of Radiation," then the full paper of Dr. Henry K. Pancoast, Professor of Roentgenology, University of Pennsylvania, Philadelphia, should be procured. The latest conception of the physics of radiant energy is lucidly explained. This is followed by a summing-up under 14 points of all that is known concerning the therapeutic action of radiation. There is little that is new in the latter, but it is in such form as will make it easy to review the subject.

E. W. ROWE, M. D.

Peristalsis in Health and Disease, Walter C. Alvarez, M. D., San Francisco, Calif. Am. Jr. Roent. Jan. 1920., Page 1.

PRACTICAL problems are often unsolved because we do not go back far enough. Before beginning his work on the gastro-intestinal

tract the doctor found he must study the lower animals first. Helpful hints were obtained from snails, sea-cucumbers, anemones, jelly-fish, clams, worms and crawfishes. Medical indices are not of much use. What is helpful is often hidden behind unsuggestive titles.

The thesis with which he starts is this: "The forces which bring about, modify and control peristalsis must be looked for within the gut itself." In his summary he gives the main points which he has discussed most fully, and after reading carefully one feels he has made a real contribution to pure science that must have practical value.

Summary.

1. The digestive tract is largely autonomous, and the forces underlying peristalsis must be looked for mainly within the gut itself.

2. The tendency of writers to explain everything on the basis of nervous reflexes and ganglionic control is unfortunate, and paralyzing to further progress.

3. Recent biologic work has shown in numberless ways that the main function of the nervous system is conduction.

4. It has been shown conclusively that the rhythmical contractions of the intestinal muscle are myogenic in origin.

5. Auerbach's plexus serves to conduct stimuli and to co-ordinate the activities of different parts of the tract. It contains no reflex arc.

6. Current theories about the antagonism between the vagus and sympathetic nerves are shown to be pseudoscientific, and out of harmony with the facts as determined by the leading anatomists and physiologists of the world today. The sympathetic is an integral part of the central nervous system and not an outlying, antagonistic "brain."

7. Many of the conclusions based upon the supposed actions of drugs on nerve-endings and "intermediate substances" must be revised in the light of recent work.

8. The extrinsic nerves of the intestine serve to communicate between the body and the bowel, and between the bowel and the brain.

9. The digestive tract can work quite normally after section of all the extrinsic nerves.

10. The key to an understanding of peristalsis is to be found in a study of the smooth muscle in the wall of the bowel.

11. There are different types of muscles, suited to different functions in the different parts of the body and in different parts of the digestive tract.

The name "gradient" is introduced and used to express the direction of the wave movement in peristalsis.

Gradients:

(a) A peristaltic wave spreads both ways from a stimulated spotlike ripples from a stone thrown into a pond. Most of the muscular tubes are so constructed that the ripples can travel in one direction better than in another.

(b) It may be a law for all tubular organs that the transport of material in one direction depends upon gradients of rhythm, irritability, tone and metabolism. Such gradients can easily be demonstrated in the walls of the stomach and intestine.

(c) A bolus moves aborally in the digestive tract because the pressure is greater on the upper than on the lower side. This difference is due probably to the graded characteristics of the muscle.

(d) The peculiarities of peristalsis in different parts of the tract are explainable on the basis of local differences in the structure of the neuromuscular mechanism.

(e) It is shown how the gradients may be upset in disease, and how these theories can explain pathologic pneumonia.

E. W. ROWE, M. D.

Quick, Douglas, The Combination of Radium and the X-Ray in Certain Types of Carcinoma of the Breast. (Surg. Gynec. and Obst., Vol. 32, No. 2, Feb., 1921).

THE writer reviews the existent literature briefly, and quotes some interesting early results. He notes that in the past, radium and x-ray have not been sufficiently combined. He describes the technique in use at the Memorial Hospital for burying emanation tubes in the tissue; presents an outline of the histologic changes which follow such a procedure and which furnish a rational basis for radium therapy. He thinks that the results following the burial of small emanation tubes (2 or 3 mc.) is better than those following the same total dosage delivered in a shorter time. Filtration, in this method, is through

a thin glass wall only, and this permits the use of nearly all of the beta radiation—a very important factor. Subsequent x-ray treatment is carried out as though no radium treatment had been given. During the past two and one-half years, seventy-eight cases of carcinoma of the breast have been thus treated at the Memorial Hospital. Of these seven show complete regression, and have remained well for periods of from three months to two years. Twenty-one cases show a partial regression, and are still progressing. No case in this group has been observed less than five months. Twenty-four cases showed temporary benefit; nineteen of these have died, but without lighting up of the original process. Ten cases showed no improvement. These were far advanced cases with widespread metastases, nine cases were not followed. Seven cases have been under observation too short a time for any report. Twelve of the foregoing cases are reported in detail, with micro-photographs illustrating the histologic changes occurring. Fifty-eight of these cases were treated for recurrences and metastatic growths. Only one of these was operable. He notes that radium seems to control the pleural pain better than x-ray. He concludes that the x-ray is useful in the treatment of every case of mammary carcinoma, that radium may be combined with x-ray to great advantage in a certain number of cases; that radium is useful mainly in flat or bulky recurrences, avillary involvement, inoperable primary cases, and in cases refusing operation; and that radium and x-ray may convert an inoperable case into an operable one at times.

LOWELL S. GOIN, M. D.